

3. DESIGN CRITERIA

3.1 Introduction

The design requirements and provisions for the Group 4 remedial actions were developed to implement WAG-3 OU 3-13 ROD stipulations. The final design was arrived at through the Data Quality Objective (DQO) process. The DQO process is a systematic planning tool based on the scientific method for establishing criteria for data quality and for developing data collection designs. DQOs have been developed to guide monitoring of the perched water drain-out. The design criteria for the main components of Phase I and Phase II activities are described below.

3.2 Description of Phase I and Phase II Activities

3.2.1 Phase I Discussion

The basic objective for the Phase I monitoring is to collect data regarding the hydrologic system at INTEC while the percolation ponds are still operating. Of primary importance is to evaluate the hydrologic connection between recharge sources surrounding INTEC and the perched water observed in the subsurface beneath INTEC. These data will be used to finalize the Phase II monitoring plan and to support interpretation of the Phase II monitoring results.

3.2.1.1 Monitoring Well Installations. Additional monitoring wells are necessary to support the evaluation of recharge sources and their impact on perched water beneath INTEC. Five new well sets (total of 15 wells) will be installed in Phase I. The primary criteria for selection of the Phase I well set locations are that they: 1) be near known significant recharge sources, or locations suitable for evaluating effect of recharge sources on the perched water beneath the Tank Farm, 2) are completed in the primary perched water zones, and 3) will support the tracer study. The primary recharge sources to be evaluated are the INTEC percolation ponds, the BLR, and the sewage treatment lagoons. Well sets will be installed near each of these recharge sources with a total of 3 wells in each set. One well in each set will be completed at the base of the surface alluvium (approximately 40 feet bgs), one in the shallow perched water zone (approximately 110 to 140 feet bgs), and one in the deep perched water zone (approximately 380 feet bgs). A fourth well set will be installed approximately mid-way between the percolation pond and tank farm with wells completed in the shallow and deep perched water zones. Last, the fifth well set will be installed at the northwest corner of the tank farm with wells completed in the alluvium, shallow and deep perched zones, and at the top of the SRPA. These wells will support the tracer study by providing perched water sampling points near each of the major recharge sources into which the tracers will be injected.

3.2.1.2 Baseline Sampling. The Phase I initial perched water sampling activity is primarily intended to provide a baseline data set from which to observe trends in COC concentrations throughout the Phase II monitoring program. Samples will be collected from each perched water monitoring well that has standing water and analyzed for the Group 4 COCs.

In addition to providing data for COC concentration determinations, the baseline sampling activity will also provide background tracer concentration data to support evaluation of the tracer test. As discussed in the Tracer Test Plan (DOE/ID-10762), several of the tracers to be used for the OU 3-13 Group 4 tracer test have been used at or near the INTEC facility previously, specifically rhodamine WT and fluorescein. In addition, geochemistry data will be collected from a number of surface water sources and monitoring wells to support a geochemical evaluation of the source(s) of perched water collected at each monitoring well. Some of the surface sources to be sampled include percolation ponds, BLR,

sewage lagoons, and potable water supply systems to provide a background source term sampling event. Lastly, hazardous-constituents samples will be collected to determine if any hazardous constituents exist in the perched water that exceed drinking water standards.

3.2.1.3 Tracer Study. The primary design criteria for the tracer study is to provide data regarding the hydrologic connection between primary sources of perched water recharge and the perched water zones observed beneath INTEC and the rate of migration of contaminants in the subsurface. To support this objective, tracers will be injected into each of the primary surface water recharge sources at INTEC including the percolation ponds, the BLR, and the sewage treatment lagoons. The tracer study will also support the final design and selection of new well locations for the Phase II monitoring program.

3.2.2 Phase II Discussion

The basic objective for the Phase II monitoring is to collect data supporting the contingent remedial action decision. Because the primary basis for the decision will be perched water drain-out and estimates of the COC flux to the SRPA outside the INTEC security fence through the year 2095, the Phase II monitoring program must include monitoring of both the moisture content and COC concentrations in the vadose zone, as well as sampling for COC concentrations in the vadose zone and SRPA beneath INTEC (inside the security fence).

It should be noted that the Group 4 Phase II monitoring program does not include the sampling of SRPA water except in the three skimmer wells. Monitoring of the SRPA beneath INTEC is an important component of the Group 4 remedy and required to estimate the flux of COCs from the perched water to the SRPA outside the INTEC security fence. This is being performed under the Group 5 SRPA monitoring program. In order to meet the Group 4 data requirements, wells USGS-40, -42, -47, -48, -49, -51, -52, -121, -122, -123, and MW-18 will require monitoring.

3.2.2.1 Well Installation. The Phase II well installations will complete the monitoring well network to support the long-term monitoring program that will begin after the INTEC service wastewater percolation ponds are removed from service. Criteria for the selection of Phase II well locations will be revised if necessary based on the results of the Phase I tracer study. Preliminary criteria for the selection of the Phase II well locations include placement near known areas of significant surface contamination such as the tank farm, placement near areas that will help define boundaries and connectivities of perched water bodies, and placement to support definition of zones of high COC concentrations in the subsurface. The Phase II monitoring wells will also be used to further refine estimates of COC flux to the SRPA and will include skimmer wells completed at the top of the SRPA, as well as monitoring the shallow and deep perched water.

3.2.2.2 Long-Term Monitoring. The primary criteria for the Phase II long-term monitoring program is to provide sufficient data to evaluate the effectiveness of the Group 4 remedial action, evaluate whether the Group 4 RAOs will be met, and support the contingent remedial action decision five years after the percolation pond relocation. Because the decision will be based upon whether moisture contents and the COC flux have been reduced to meet RAOs, both moisture content and COC concentrations must be monitored during Phase II. Since there are several sources of recharge water, the Phase II monitoring well network must be sufficiently distributed to determine the effects of each recharge source on the migration of contaminants beneath INTEC. (Note: as discussed above, additional wells will be installed in Phase II to augment the monitoring well network that is determined necessary to evaluate the remedial action.) Finally, because the contingent remedial action decision must be made five years after relocation of the percolation ponds, the frequency of COC sampling activities and moisture monitoring should be appropriate to monitor trends which may be occurring during that five-year period.

3.3 Group 4 Phase I and II Data Quality Objectives

The EPA developed the DQO process as a means to “improve the effectiveness, efficiency, and defensibility of decisions” used in the development of data collection designs (EPA, 1994). The DQO process is a systematic procedure for defining data collection criteria based on the scientific method. This process consists of seven iterative steps that yield a set of principal study questions and decision statements that must be answered to address a primary problem statement. The seven steps comprising the DQO process are listed below:

- Step 1: State the problem.
- Step 2: Identify the decision.
- Step 3: Identify the inputs to the decision.
- Step 4: Define the study boundaries.
- Step 5: Develop decision rules.
- Step 6: Specify limits on the decision.
- Step 7: Optimize the design for obtaining data.

The following sections present details on each of the DQO steps to be answered by the work conducted under this FSP. The DQOs as discussed in the following sections have been negotiated and approved by the supervising agencies. Table 3-1 presents a summary of the DQO process for the Group 4 remediation goals.

3.3.1 State the Problem

The OU 3-13 ROD requires a determination of whether relocation of the percolation ponds is sufficient to meet the OU 3-13 Group 4 remediation goals. The ROD establishes two remediation goals for the perched water of 1) “reduce recharge to the perched water,” and 2) “minimize migration of contaminants to the SRPA, so that SRPA groundwater outside of the current INTEC security fence meets the applicable State of Idaho groundwater standards by the year 2095” (ROD, Sect 8.1.4, p 8-9).

If these goals are not met, then additional infiltration controls are required. Per the ROD, the next remedial action would be lining the BLR, if relocation of the percolation ponds is not successful in meeting the remediation goal.

Perched water at INTEC has been identified as potentially two distinct areas, the northern perched water and southern perched water (ROD, Figure 1-6, pg. 1-8). Perched water is also differentiated between a shallow perched water zone (approximately 110 to 140 ft bgs) and a deep perched water zone (approximately 380 ft bgs).

For the DQO process, the problem can be stated this way: Is relocating the percolation ponds successful in meeting the OU 3-13 Group 4 remediation goals (that is, preventing migration of radionuclides from perched water in concentrations that would cause the SRPA groundwater to exceed drinking water standards in 2095), or are additional infiltration controls necessary?

3.3.2 Identify the Decisions

This step of the DQO process identifies the principal study questions (PSQs), alternative actions (AAs), and corresponding decision statements (DSs) that must be answered to effectively address the above-stated problem. The primary decision is to determine whether relocation of the percolation ponds is successful in preventing migration of radionuclides from perched water in concentrations that would cause the SRPA groundwater to exceed drinking water standards in 2095 and beyond. If relocation of the percolation ponds is insufficient to meet this goal, then additional recharge controls will be necessary, as stated in Section 8.1.4 of the ROD. Such actions are outside the scope of this MSIP. Evaluation of the success of relocation of the percolation ponds will be based upon whether the Group 4 remediation goals (ROD, Sec 8.1.4, pg. 8-9) can be demonstrated as being met. To further assist in this evaluation, the vadose zone modeling conducted as part of the WAG 3, OU 3-13 RI/FS will be utilized. This model predicted that removing the current percolation ponds from service would result in the existing perched water bodies reaching a steady state with the BLR approximately 14 years after the ponds are removed from service.

3.3.2.1 Principal Study Questions. The purpose of a PSQ is to identify key unknown conditions or unresolved issues that, when answered, provide a solution to the problem being investigated. The PSQs for this project are as follows:

- PSQ-1a: Has the moisture content in the vadose zone beneath INTEC been reduced to or below moisture levels predicted by the WAG-3 OU 3-13 vadose zone model (DOE-ID 1997b and 1998) within five years following the percolation pond relocation?
- PSQ-1b: Has the COC flux from the perched water to the SRPA been reduced, during the initial five years of monitoring, following the percolation pond relocation such that water quality in the SRPA will meet applicable standards by 2095? COCs include those contaminants identified in the ROD and may be supplemented by those identified following the first round of contaminant sampling. COCs include tritium, technicium-99, iodine-129, strontium-90, plutonium isotopes (Pu-238, -239/240, -241), uranium isotopes (U-234, -235, -238), neptunium-237, americium-241, cesium 137, and mercury.
- PSQ-2: Based upon monitoring of the percolation pond relocation (PSQ-1a and PSQ-1b), are additional recharge controls necessary required?
- PSQ-3: Based upon new data obtained during evaluation of the percolation pond relocation and an evaluation of recharge sources, is lining of the BLR the recommended alternative if additional recharge controls are necessary?

3.3.2.2 Alternative Actions. AA are those actions possible resulting from resolution of the above PSQs. The types of actions considered will depend on the answers to the PSQ's.

- AA-1a: Alternatives to PSQ-1a include (1) determining whether the measured moisture content is less than or equal to levels predicted by the WAG 3 OU 3-13 model or 2) whether the measured moisture content remains greater than that predicted by the model.
- AA-1b: The alternative to PSQ-1b is that the COC flux from the perched water to the SRPA will result in groundwater concentrations in the SRPA exceeding MCLs or RAOs/remediation goals (RGs) in 2095 and beyond.

- AA-2: Alternatives to PSQ-2 will be based upon the answers obtained to PSQ-1a and PSQ-1b and include determining whether implementation of additional recharge control is required.
- AA-3: Alternative actions for PSQ-3 include determining whether lining the BLR is the preferred alternative for meeting the perched water RAO or determining whether other recharge control or combination of controls are recommended.

3.3.2.3 Decision Statements. The DS combine the PSQ and AA into a concise statement of action. The DS for each of the PSQs are stated below.

- DS-1a: Determine whether relocation of the percolation ponds has been sufficient to reduce moisture content in the vadose zone to levels less than or equal to those predicted by the WAG-3 OU 3-13 vadose zone model.
- DS-1b: Determine whether relocation of the percolation ponds has reduced the flux of COCs from perched water to the SRPA such that the predicted COC concentrations in the SRPA will not exceed MCLs or RAOs/RGs in 2095 and beyond.
- DS-2: Based upon the results of PSQ-1a and PSQ-1b, determine whether additional recharge control (which may include lining the BLR) is required. If the answers to both PSQ-1a and PSQ-1b are yes, then the RG have been met and additional recharge control is not required. If the answer to either PSQ-1a or PSQ-1b is no, then the remediation goals have not been met and further action is required.
- DS-3: Determine whether additional recharge controls are required for meeting the RAOs and which recharge controls will be most effective.

It is important to realize that the installation of an updated monitoring system and collection of new types of data during the post-ROD monitoring might modify the site conceptual model for vadose zone flow and transport beneath WAG 3. If the conceptual model is significantly changed, DS 1 may need to be reevaluated in terms of the updated conceptual model.

These PSQs, AAs, and DSs are presented in tabular form in Table 3-1.

3.3.3 Identify Inputs to the Decision

This step of the DQO process identifies the informational inputs that are required to answer the DSs identified above.

3.3.3.1 Inputs for PSQ-1a “Moisture Monitoring”. PSQ-1a will be answered by a comparison of field measurements of vadose zone soil moisture to the predicted WAG 3 vadose zone model soil moisture. The comparison of field data to model-calculated predictions will be accomplished through the comparison of spatially-averaged field data from four zones of the INTEC subsurface to calculated predictions from approximately the same volume within the numerical model domain. To facilitate this comparison, the INTEC subsurface will be divided into four discrete zones based upon the north and south perched water areas, and the deep and shallow interbed depths. This will produce the following four subsurface zones: the north-shallow, north-deep, south-shallow, and south-deep zones.

The inputs to PSQ-1a are:

1. Spatially-distributed matric potential measurements from new tensiometers installed within each subsurface zone at INTEC
2. WAG 3 OU 3-13 vadose zone numerical model-derived matric potential action levels for each of the same subsurface zones
3. Moisture characteristic curves for the interbed sediments
4. Tracer test data to evaluate hydraulic continuity of perched zones, recharge sources, and travel times from those sources to the perched zones. (The tracers will be unique fluorescent dyes, which are not currently being used at the INEEL.)

3.3.3.2 Inputs for PSQ-1b “COC flux Evaluation”. In order to estimate contaminant flux following relocation of the percolation ponds and to support numerical modeling, information is required regarding: a) time-series concentrations and aerial distribution of contaminants in the vadose zone beneath INTEC, b) water flux through the area of contamination in the vadose zone beneath INTEC, c) material properties of the subsurface sediments and contaminants affecting contaminant transport in the vadose zone, d) time-series concentrations and distribution of contaminants in the SRPA beneath INTEC, e) water flux through the SRPA beneath INTEC, and f) material properties of the SRPA material and contaminants affecting the contaminant transport.

The inputs to PSQ-1b are:

1. Sample collection and chemical analysis for COCs in perched water samples from existing vadose zone monitoring wells
2. Collection and chemical analysis for COCs of soil water samples from new lysimeters installed with new tensiometers
3. Measurement of water levels in existing vadose zone monitoring wells
4. Measurements of soil moisture tension from new tensiometers
5. Collection and analysis of interbed sediment samples at locations of new tensiometers for development of moisture characteristic curves and grain size analysis
6. Collection and chemical analysis for COCs in groundwater samples from new and existing monitoring wells installed in the SRPA
7. Collection and chemical analysis of tracers in perched water
8. Measurement of water levels in new and existing monitoring wells installed in the SRPA
9. Precipitation information obtained from outside sources for recharge water source information
10. Big Lost River flows, and facility discharge volumes
11. Incorporation of monitoring data, collected during the five years after relocation of the percolation pond, into a refined WAG 3 OU 3-13 model, and calculation of the predicted concentrations of COCs in the SRPA in 2095 and beyond.

Table 3-1. WAG 3 OU 3-13 Group 4, Perched Water DQO Table.

1: State the Problem	2: Identify the Decision			3: Identify Inputs to the Decision	4: Define the Study Boundaries
Is relocating the percolation ponds successful in meeting the OU 3-13 Group 4 remediation goals (i.e., preventing migration of radionuclides from perched water in concentrations that would cause the SRPA groundwater to exceed drinking water standards in 2095), or are additional infiltration controls necessary? Per the ROD, the next contingent remedial action will be lining the BLR, if relocation of the percolation ponds is not successful in meeting the remediation goal.	Success at meeting the remedial action objective will be based upon a determination of whether we have met the Group 4 remediation goals (ROD, Sec 8.1.4, p 8-9).				This study focuses on the transport of COCs from the vadose zone to the SRPA. Specifically excluded from this study is contamination of the surface soils (alluvium to top of basalt) at INTEC which are covered under other programs. The physical boundaries of the study area are from the BLR (on the north) to the percolation ponds at the south end of INTEC. The east-west boundaries roughly correspond to the east-west perched water zones and include the sewage treatment lagoons and probably a portion of the BLR. At depth, the boundaries of the study area are from the top of basalt down and into the top of the SRPA. To aid in the remedial action evaluation and based on the physical characteristics of the perched water bodies and locations of recharge sources, the vadose zone will be divided into a northern-upper, northern-lower, southern-upper, and southern lower perched water zones. The boundary between north and south will be marked by an east-west line across the southern end of the FAST building (CPP-666). The boundary between the upper and lower perched water is placed at a depth of 200 feet between what is commonly referred to as the upper interbeds (110-140 ft) and lower interbeds (~380 ft). The division of the vadose zone into four discrete study areas allows for independent review of each of these areas as the remedial action progresses. The tracer test data will be used to determine the connectivity between the perched water zones for compliance monitoring. The Group 4 remedial activities will be undertaken in three phases. The purpose of the first phase is to obtain information and background data while the percolation ponds are working to establish compliance monitoring and will include installation of 15 wells, conducting a series of tracer tests, and monitoring moisture content and COC concentrations. The purpose of Phase II is to monitor the drain out of the perched water following relocation of the percolation ponds and will include drilling additional wells. Phase III includes the BLR contingency (if required) and long-term monitoring. Lining of the BLR will require fulfilling additional requirements such National Environmental Policy Act of 1969 and a factual determination per CFR Title 40, Part 230, Section 404(B)(1), Guidelines for Specification of Disposal Sites For Dredged or Fill Material, modification to the SOW, and possibly, additional field investigations to support an experiment specification document (ESD) or ROD amendment.
	Principal Study Questions	Alternative Actions	Decision Statement		
	PSQ-1a: Has the moisture content in the vadose zone beneath INTEC been reduced to moisture levels predicted by the WAG-3 OU 3-13 vadose zone model (DOE-ID 10572) within 5 years following the percolation pond relocation? Note 1: Data to resolve this question will be collected before and after the removal of the percolation ponds. Note 2: Data to answer PSQ-1a will initially be compared with data from the existing OU3-13 vadose zone model. The collected data will be used to revise the model. After the model is revised, it will be used to predict future conditions.	AA-1a: Alternatives to PSQ-1a include 1) determining whether the measured moisture content is less than or equal to levels predicted by the WAG 3 OU 3-13 model or 2) determining whether the measured moisture content remains greater than that predicted by the model.	DS-1a: Determine whether relocation of the percolation ponds has been sufficient to reduce moisture contents in the vadose zone to levels less than or equal to those predicted by the WAG-3 OU 3-13 vadose zone model.	The inputs to PSQ-1a are: 1) Spatially distributed matric potential measurements from new tensiometers installed within each of the subsurface zones at INTEC 2) WAG-3 OU 3-13 vadose zone numerical model derived matric potential action levels for each of the same subsurface zones 3) Moisture characteristic curves for the interbed sediments 4) Tracer test data a) Tracers will be unique fluorescence dyes, which are not currently being used at the INEEL b) Tracer tests will be performed to evaluate hydraulic continuity, recharge sources, and travel times.	
	PSQ-1b: Has the COC* flux to the SRPA been reduced during the initial 5 years of monitoring following the percolation pond relocation such that water quality in the SRPA meet applicable standards by 2095? *COCs include those contaminants identified in the ROD and may be supplemented by those identified following the first round of contaminant sampling. COCs include tritium, technicium-99, iodine-129, strontium-90, plutonium isotopes, uranium isotopes, and mercury. Note: If there are changes to COC Kd's per OU 3-14 or INTEC evaluation, these will be incorporated by consensus as appropriate	AA-1b: The alternative to PSQ-1b is that the COC flux to the SRPA will result in groundwater concentrations in the SRPA exceeding MCLs or RAOs/RGs in 2095 and beyond.	DS-1b: Determine whether relocation of the percolation ponds has reduced the flux of COCs to the SRPA such that the predicted COC concentrations in the SRPA will not exceed MCLs or RAOs/RGs in 2095 and beyond.	The inputs to PSQ-1b are: 1) Collection and chemical analysis for COCs of perched water samples from existing vadose zone monitoring wells 2) Collection and chemical analysis for COCs of soil water samples from new and existing lysimeters 3) Measurement of water levels in existing vadose zone monitoring wells 4) Measurements of tension from new tensiometers 5) Collection and analysis of interbed sediment samples at locations of new tensiometers for development of moisture characteristic curves and grain size analysis 6) Collection and chemical analysis for COCs of groundwater samples from new and existing monitoring wells installed in the SRPA 7) Collection of and chemical analysis of tracers in perched water 8) Measurement of water levels in new & existing monitoring wells installed in the SRPA 9) Recharge water source information for precipitation, BLR flows, and facility discharge volumes 10) Incorporation of monitoring data, collected during the 5 years following relocation of the percolation pond, into the refined WAG-3 OU 3-13 model and calculation of the predicted concentrations of COC in the SRPA in year 2095 and beyond.	
	PSQ-2 Based upon monitoring of the percolation pond relocation (PSQ-1a and PSQ-1b), are additional recharge controls necessary?	AA-2: Alternatives to PSQ-2 will be based upon the answers obtained to PSQ-1a and PSQ-1b and include determining whether implementation of additional recharge control is required.	DS-2: Based upon the results of PSQ-1a and PSQ-1b, determine whether additional recharge control is required. If the answers to both PSQ-1a and PSQ-1b are yes, then the remediation goals have been met and additional recharge control is not required. If the answer to either PSQ-1b or PSQ-1b is no, then the remediation goals have not been met and further action is required.	The inputs to PSQ-2 are: PSQ-1a and PSQ-1b will be inputs to PSQ-2. Both PSQ-1a and PSQ-1b will have either a “yes” or “no” answer. No additional field data is required for PSQ-2.	
	PSQ-3 Based upon new data obtained during evaluation of the percolation pond relocation and an evaluation of recharge sources, is lining of the BLR the recommended alternative if additional recharge controls are necessary?	AA-3: Alternative actions for PSQ-3 include determining whether lining the BLR is the preferred alternative for meeting the perched water RAO or determining whether recharge control or combination of controls are recommended.	DS-3: Determine whether additional recharge controls are required for meeting the RAO and which additional recharge controls will be needed.	The inputs to PSQ-3 may include: 1) Time-series water level and tension measurements in existing monitoring wells and in the Phase I and II wells. 2) Time-series data obtained from National Oceanic and Atmospheric Administration, USGS, and INTEC operations for information impacting recharge including BLR flow data; precipitation, temperature, pressure records; and percolation pond, sewage treatment lagoons, and other operational (if required) discharge volumes. 3) Perched water sample collection and analysis for tracers. 4) Perched water sample collection and analysis for basic geochemistry, e.g., anions and cations; isotopes, e.g. N14/N15 ratios; and source or recharge indicator chemicals, e.g., nitrates, caffeine, chloride. 5) Collection and analysis of source term waters for the same suite of analytes as perched water samples. Note: A final decision on exactly what the PSQ-3 inputs will be determined with Agency input following PSQ-2.	
DOE/ID, 1997, <i>Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part B, FS Report (final)</i> , DOE/ID-10572.					

Table 3–1. (continued).

5: Develop a Decision Rule	6: Specify Tolerable Limits on Decision Errors	7: Optimize the Design
DR-1a: If, five years following the percolation pond relocation, the mean soil moisture content in the vadose zone sections, (e.g., north-upper, north-lower, south-upper, and south-lower), is equal to or less than the mean tension predicted by the refined WAG-3 OU 3-13 vadose zone model, then we can conclude that we have met the first remediation goal for Group 4.	<p>The average soil tension measurement in each of the zones will be compared to the established action level for each zone. COC flux concentrations will be compared to MCL or RG values and established action levels.</p> <p>When data can be statistically manipulated, hypothesis testing will be utilized to determine if the action level is exceeded in any of the zones. The recommended null hypothesis, H₀, is that the true mean in each zone is greater than the action level. The alternative hypothesis is that the mean is less than or equal to the action level:</p> <div><div>H₀:</div><div>μ > Action Level</div><div>H_a:</div><div>μ ≤ Action Level</div></div>	<p>The design for the WAG-3 OU 3-13 Group 4 investigation will be implemented in phases. Phase I includes installation of five well sets to be drilled prior to conducting the tracer test. Vadose zone well sets will be located south of the BLR on the northwest corner of the tank farm, in a central location within the INTEC facility, west of the sewage disposal lagoons, and north of the existing percolation ponds. Phase I well sets will include a combination of: alluvial wells with instrumentation installed at about 45 ft bgs, upper perched water wells with instrumentation installed at about 120 to 140 ft bgs, lower perched water wells with instrumentation installed at about 380 to 420 ft, and possibly an aquifer well at about 460 ft. The justification for each Phase I well set follows. Big Lost River Well Set This well set is located south of the BLR. The alluvial well will provide a location for sampling any perched water that develops in the alluvium as result of flow in the BLR. The upper and lower perched water wells will provide locations for sampling the perched water zones in the northern INTEC area. The set is placed in a location near the BLR where monitoring wells currently do not exist. These wells will serve as the monitoring points for the BLR tracer (and other tracers should they be present). Wells at this location will help define the northern boundary and vertical extent of the perched water zones and will help identify the hydraulic connection between the river an the perched water zones. Sewage Treatment Lagoons Well Set This well set is located southwest of the sewage treatment lagoons. The well set will provide sampling locations in northern INTEC in the alluvium (should any perched water develop in the alluvium as result of flow in the BLR or discharge from the sewage treatment lagoons) and in the upper and lower perched water. The set is placed in a location near the sewage treatment lagoons where no monitoring wells in the perched water currently exist. This well set will serve as the alluvium/basalt interface, upper, and lower perched water-monitoring points for the tracers. The wells at this location will help define the vertical depth and the northeastern boundary of the perched water zones. The wells will also provide information on the hydraulic connection between the river, the sewage treatment lagoons, and the perched water zones. Percolation Pond Well Set This well set will provide a location for sampling perched water that develops on the alluvium and in the upper and lower perched water as result of wastewater disposal in the percolation ponds. The wells will be placed north of the percolation ponds at a location where no monitoring wells in the alluvium currently exist. (However, upper perched water wells exist to the north and south, and one lower perched water well exists to the north.) This well set will serve as monitoring points for the tracer introduced into the percolation ponds (and others if they are present). The wells will help identify the locations and vertical depth of the perched water and provide information on the hydraulic connection between the percolation ponds and the perched water zones. Tank Farm Well Set This well set will be located on the northwest corner of the tank farm (see Figure 4-1) and will include four wells: alluvium, upper perched water, lower perched water, and aquifer skimmer. The location for this well set was selected to provide a monitoring point between the BLR and the tank farm and to access contaminated water that might move to the northwest from the tank farm. These wells will help define effects of the BLR flow on the perched water at the alluvium/basalt interface, in both perched water zones, and in the SRPA. Central Well Set. This well set is located in a central location between the north and south perched water bodies (see Figure 5-1). The cluster will monitor the shallow perched water and deep perched water zones. As nearby perched water wells (MW-11, MW-11P) have been dry at recent measurement events, the tensiometer and lysimeter data collected from this location will provide valuable information.</p> <p>Instrumentation in Phase I wells will include piezometers, deep tensiometers (to measure soil tension), suction lysimeters (for collecting water samples), and possibly moisture sensors. The piezometer will be installed in the borehole at the primary perched water zone. The suction lysimeters will be installed in the primary perching zone and other “wet” zones. A suction lysimeter will be placed in the well at primary perched water zone to determine contaminate concentrations for flux calculations following perched water drain out. The data may be used to determine contamination or recharge sources. If the moisture sensors can be successfully installed, field scale moisture characteristic curves will be developed.</p> <p>In Phase I, a unique tracer will be added to each of the major recharge sources: existing percolation ponds, the BLR, (tracer probably cannot be added directly to the river, [it will all flow off downstream], so it will be added to the vadose zone under or beside the river) and the sewage treatment lagoons. Perched water will be sampled and analyzed for tracer concentrations and other analytes to augment the added tracers. Tracer data will then be used to determine extent on perched water, the impact and interconnectivity of each recharge source on perched water, and to refine the WAG-3 OU 3-13 model.</p> <p>Phase I will also include collecting soil tension data from the Phase I perched water wells, collecting water samples from newly installed instrumentation as well as existing perched water wells and analyzing data for COCs and water geochemistry. COC analytes may include tritium, technicium-99, iodine-129, strontium-90, plutonium and uranium isotopes, mercury, and other hazardous constituents in addition to the COCs listed in the ROD. The hazaardous substances may include carbpn tetrachloride, 1,1,1-TCA, TCE, PCE, benzene, toluene, carbon disulfide, pyridine, and hydrogen fluoride. Geochemical analytes may include cations, anions, and caffeine and N14/N15. Water level data will also be collected from existing INTEC perched water wells.</p> <p>Phase II will involve installing additional well sets which may include an alluvial well (~45 ft. bgs), a shallow perched water well (~120 to 140 ft. bgs), a deep perched water well (~380 ft. bgs), and an aquifer skimmer well (~450 ft. bgs). Phase II will also include monitoring instrumentation installed in Phase I and II wells, monitoring water levels in all existing perched water wells, and COC and geochemical sampling of soil- and perched-water in new and existing wells. COCs including any additional hazardous substances will be sampled for annually during Phase I and II until the decision on the need for further recharge control is made (sometime after the 5 years following the relocation of the percolation ponds). Thereafter, they will be sampled for in 5-yr. Increments. Geochemistry samples will be collected initially (after completion of Phase I wells) and in years 2, 4, and 6 (percolation ponds will be relocated in year 2).</p> <p>Sampling and monitoring the vadose zone wells will continue during the 5 years following percolation pond removal. It is estimated that a network of about 60 wells will be sampled annually for chemical analysis. Moisture data from the same well network will be collected daily during this part of the investigation. After the 5 years provided that the drain-out is occurring as predicted, monitoring and sampling will continue in a reduced well network (~20 wells) at a reduced frequency.</p> <p>Phase III will be initiated only if the remedial contingency is implemented. In that event Phase III will include the installation of additional wells, additional recharge controls, and long term monitoring.</p>
DR-1b: If, following the 5 years of monitoring, and incorporation of those data into the refined WAG-3 OU 3-13 model, we predict through modeling that concentrations of COCs in the SRPA will be equal to or less than applicable MCLs or RGs in the year 2095 and beyond, then we can conclude that we have met the second remediation goal for Group 4.		
DR-2: If we conclude that both remediation goals have been met based upon DR-1a and DR-1b above, then we can conclude that the perched water remedial action objective has been met and additional recharge controls are not required. If we conclude that either of the remediation goals, DR-1a or DR-1b, has not been met, then the remedial action objective has not been met and per the ROD (ROD, section 8.1.4., pg 8-10), the contingency for limiting recharge from the BLR must be implemented.	<p>The hypothesis testing will be based upon small sample statistics (n < 30) and utilize the t test statistic:</p> <div><div>Test Statistic: $t = \frac{\bar{x} - hypothesized\ value}{s/\sqrt{n}}$</div></div>	
DR-3: If new data collected during the 5 years of monitoring indicate that the BLR is not a significant source of recharge to the vadose zone, then a ROD modification will be done and other recharge source(s) addressed.	<p>Using this test statistic and hypothesis, we would reject the null hypothesis (and thereby accept the alternative hypothesis) if the test statistic t is less than the negative value of the t critical value obtained from standard math tables given our number of samples and desired level of significance.</p> <p>In the case where decisions will be made by comparing data to computer predictions, the accuracy of the computer predictions will be the accuracy of the OU 3-13 model.</p>	

3.3.3.3 Inputs for PSQ-2 “Contingent Remedy Requirement”. The inputs to PSQ-2 will be the answers to PSQ-1a and PSQ-1b. Both PSQ-1a and PSQ-1b will have either a “yes” or “no” answer. No additional field data is required for PSQ-2.

3.3.3.4 Inputs for PSQ-3 “Recharge Control Validation”. If additional recharge controls are deemed necessary, the determination of which recharge controls will be most effective to reduce COC transport will require an understanding of the distribution of water from each of the potential recharge sources. Knowing the source(s) of water collected in each monitoring well will help to determine which recharge source(s) are affecting which areas of the subsurface and help to focus recharge controls on those sources which have the greatest impact on the areas of concern. This can be accomplished through the correlation of head changes in the vadose zone to periodic changes in the various recharge sources and through a geochemistry study, to directly relate waters collected at the various vadose zone monitoring wells to recharge sources.

The inputs to PSQ-3 are:

1. Time-series water level and tension measurements in existing monitoring wells and in the Phase I and II wells the
2. Time-series data obtained from National Oceanic and Atmospheric Administration, USGS, and INTEC operations for information impacting recharge including BLR flow data; precipitation, temperature, and barometric pressure records; and percolation pond, sewage treatment lagoons, and other operational discharge volumes
3. Perched water sample collection and analysis for tracers
4. Perched water sample analysis for basic geochemistry (e.g., major anions and cations), isotopes (stable isotopic ratios for nitrogen, strontium, hydrogen, oxygen), and source or recharge indicator chemicals, (e.g., nitrates, chloride)
5. Collection and analysis of source term waters for the same suite of analytes as groundwater samples.

3.3.4 Define the Boundaries of the Study

This study focuses on the transport of COCs from the vadose zone to the SRPA. Specifically excluded from this study is contamination of the surface soils from (alluvium to top of basalt) at INTEC which are covered under other programs. The physical boundaries of the study area are: from the BLR on the north to the percolation ponds at the south end of INTEC. The east-west boundaries roughly correspond to the east-west perched water zones and include the sewage treatment lagoons and probably a portion of the BLR. At depth, the boundaries of the study area are from the top of basalt down and into the top of the SRPA.

To aid in the remedial action evaluation, and based on the physical characteristics of the perched water bodies and locations of recharge sources, the vadose zone will be divided into a northern-upper, northern-lower, southern-upper, and southern-lower perched water zones. The boundary between north and south will be marked by an east-west line across the southern end of the FAST building (Chemical Processing Plant [CPP]-666). The boundary between the upper and lower perched water is placed at a depth of 200 feet bgs between what are commonly referred to as the upper interbeds (110 to 140 ft) and the lower interbeds (~380 ft bgs). The division of the vadose zone into four discrete study areas allows for independent review of each of these areas as the remedial action progresses. The

tracer test data will be used to determine the connectivity between the perched water zones for use in compliance monitoring.

The Group 4 remedial activities will be undertaken in up to three phases. The purpose of Phase I is to obtain information and background data while the percolation ponds are still in use to establish compliance monitoring, and will include installing nine wells, conducting a tracer test, and monitoring moisture content and COC concentrations. The purpose of Phase II is to monitor the drain-out of the perched water following relocation of the percolation ponds and will include drilling additional wells, along with long-term monitoring.

Phase II is contingent on the results of Phases I and II. Lining of the BLR, if necessary, will require fulfilling additional requirements such as those in the National Environmental Policy Act of 1969 and a factual determination per CFR Title 40, Part 230, Section 404(B)(1), Guidelines for Specification of Disposal Sites For Dredged or Fill Material, modification to the SOW, and, possibly, additional field investigations to support an ESD or ROD amendment, and would be conducted as contingent Phase III.

3.3.5 Develop a Decision Rule

This step of the DQO process brings together the previous outputs into a single statement describing the basis for choosing among the listed alternatives.

- Decision Rule (DR)-1a: If, five years after relocation of the percolation ponds, the mean soil moisture content in the four vadose zone sections, (north-shallow, north-deep, south-shallow, and south-deep), is equal to or less than the mean soil moisture tension predicted by the WAG 3 OU 3-13 vadose zone model, then we can conclude that we have met the first remediation goal for Group 4.
- DR-1b: If, after the five years of environmental monitoring and incorporation of those data into the WAG 3 OU 3-13 model, we predict through modeling that concentrations of COCs in the SRPA will be equal to or less than applicable MCLs or RGs in the year 2095 and beyond, then we can conclude that we have met the second remediation goal for Group 4.
- DR-2: If we conclude that both remediation goals have been met based upon DR-1a and DR-1b above, then we can conclude that the perched water RAO has been met and additional recharge controls are not required. If we conclude that either of the RGs, DR-1a or DR-1b, has not been met, then the RAO has not been met. Therefore, per the ROD (ROD, section 8.1.4, pg 8-10), the contingency for limiting recharge from the BLR must be implemented.
- DR-3: If new data collected during the five years of monitoring indicate that the BLR is not a significant source of recharge to the vadose zone, then a ROD modification must be done and other recharge source(s) addressed.

3.3.6 Optimize the Design

The design for the OU 3-13 Group 4 investigation will be implemented in phases. These phases will build on each other, allowing the design of the monitoring program to be optimized through an improved understanding of site conditions. The tasks for Phases I & II are described below.

3.3.6.1 Phase I Activities. Phase I includes installation of five well sets to be drilled prior to conducting the tracer test. Vadose zone well sets will be located south of the BLR, west of the sewage

treatment lagoons, on the northwest corner of the Tank Farm perimeter, in a location central of the INTEC facility and north of the existing percolation ponds. Phase I well sets include a combination of alluvial wells with instrumentation installed at about 13.7 m (45 ft bgs), upper perched water well with instrumentation installed at about 36.6 to 42.7 m (120 to 140 ft) bgs, lower perched water well with instrumentation installed at about 115.8 m (380 to 420 ft) bgs, and aquifer skimmer at about 140 m (460 ft) bgs. The justification for each Phase I well set follows.

- **Big Lost River Well Set.** This well set is located south of the BLR. The alluvial well will provide a location for sampling perched water that develops in the alluvium as a result of flow in the BLR. The upper and lower perched water wells will provide locations for sampling the perched water zones in the northern INTEC area. The site for this set is a location near the BLR where monitoring wells currently do not exist. These wells will serve as the monitoring points for the BLR tracer (and indicator parameters, should they be present). Wells at this location will help define the northern boundary and vertical extent of the perched water zones and will help identify the hydraulic connection between the river and the perched water zones.
- **Sewage Treatment Lagoons Well Set.** The site for this set is southwest of the sewage treatment lagoons. The well set will provide sampling locations in the northeastern portion of INTEC in the alluvium (to evaluate perched water presence in the alluvium as result of flow in the BLR or discharge from the sewage treatment lagoons) and in the upper and lower perched water. The site is near the sewage treatment lagoons where no monitoring wells in the perched zones currently exist. This well set will serve as the alluvium/basalt interface, upper, and lower perched water-monitoring points for the tracers and indicator parameters. The wells at this location will help define the vertical depth and the thickness of the perched water zones in this area. The wells will also provide information on the hydraulic connection between the river, the sewage treatment lagoons, and the perched water zones.
- **Percolation Pond Well Set.** This well set will provide a location for sampling perched water that has developed in the alluvium and in the upper and lower perched water as a result of wastewater disposal in the percolation ponds. The wells will be placed north of the percolation ponds at a location where no monitoring wells in the alluvium currently exist. (Upper perched water wells exist to the north and south, and one lower perched water well exists to the north.) This well set will serve as monitoring points for the tracer introduced into the percolation ponds (and indicator parameters, should they be present). The wells will help identify the locations and vertical depth of the perched water and provide information on the hydraulic connection between the percolation ponds and the perched water zones.
- **Tank Farm Well Set.** This well set will be located on the northwest corner of the tank farm (see Figure 5-1) and will include four wells: alluvium, upper perched water, lower perched water, and aquifer skimmer. The location for this well set was selected to provide a monitoring point between the BLR and the tank farm and to access contaminated water that might move to the northwest from the tank farm. These wells will help define effects of the BLR flow on the perched water at the alluvium/basalt interface, in both perched water zones, and in the SRPA.
- **Central Well Set.** This well set is located in a central location between the north and south perched water bodies (see Figure 5-1). The cluster will monitor the shallow perched water and deep perched water zones at depths of approximately 120 to 140 ft bgs and 380 to 420 ft bgs, respectively. As nearby perched water wells (MW-11, MW-11P) have been dry at recent measurement events, the tensiometer and lysimeter data collected from this location

should provide valuable information. Regarding vadose zone moisture conditions mid-way between the percolation ponds and tank farm.

Instrumentation in Phase I wells will include a piezometer, deep tensiometers (to measure soil tension), suction lysimeters (for collecting water samples), and possibly soil moisture sensors. The piezometer will be installed in the borehole at the primary perched water zone. The suction lysimeters will be installed in the primary perching zone and other “wet” zones. A suction lysimeter will also be placed in the well at the primary perched water zone to determine contaminate concentrations for flux calculations following perched water drain-out. The data may be used to determine contamination or recharge sources. If the moisture sensors can be successfully installed, field scale moisture characteristic curves will be developed.

In Phase I, a unique tracer will be added to each of the major recharge sources: existing percolation ponds, sewage treatment lagoons, and the BLR, as discussed in the Tracer Test Plan (Appendix D). During the Tracer Test, perched water will be sampled and analyzed for tracer concentrations, and if necessary, other chemical and isotopic ratios to augment the tracer data. Tracer data will then be used to determine the extent of perched water, the impact and interconnectivity of each recharge source on perched water, and to refine the conceptual and WAG-3 OU 3-13 numerical models.

Phase I will also include collecting soil moisture tension data from the Phase I perched water wells, collecting water samples from lysimeters in newly installed and existing perched water wells and analyzing data for COCs and water geochemistry. COC analytes include tritium, technetium-99, iodine-129, strontium-90, plutonium isotopes (Pu-238, -239, -240, -241) uranium isotopes (U-234, -235, -238), neptunium-237, cesium-137, and mercury. In addition to the COCs listed in the ROD, other hazardous constituents will be initially analyzed for and include 1,1,1-TCA, carbon tetrachloride, TCE, PCE, benzene, toluene, and carbon disulfide. Several stable isotopic ratios will be evaluated along with the constituents listed above if an independent research project receives funding. The isotopic ratios of nitrogen, oxygen, strontium, and hydrogen have been identified for this research. Final notification of funding will be made near the end of FY 2000. Water level data will also be collected from existing INTEC perched water wells.

Phase I findings will provide information on the extent and mixing of the perched waters from the “major” recharge sources. Additional wells may be installed in Phase II. The locations of the additional wells will be determined by input from the following criteria: 1) tracer test results, 2) proximity to recharge sources, 3) proximity to potential contamination sources, and 4) representation of the INTEC perched water.

3.3.6.2 Phase II Activities. Phase II involves installing additional well sets, each of which may include an alluvial well (~45 ft bgs), a shallow perched water well (~120 to 140 ft bgs), a deep perched water well (~380 ft bgs), and an aquifer skimmer (screened across the water table) well (~450 ft bgs).

Phase II will also include installing monitoring instrumentation similar to that in Phase I, monitoring water levels in all existing perched water wells, and COC and geochemical sampling of soil and perched water in new and existing wells. COCs, including any additional hazardous substances which were found to exceed MCLs in Phase I sampling, will be sampled for annually during Phase I and II until the decision on the need for further recharge control is made (five years after the relocation of the percolation ponds). Sampling frequency, analytes, sampling locations, may be changed following five years of Phase II monitoring. Geochemistry samples will be collected initially (after completion of Phase I wells) and in years 2, 4, and 6 (assuming percolation ponds will be relocated in year 2).

Sampling and monitoring of the vadose zone wells will continue during the five years after percolation pond removal. It is estimated that a network of 60 wells will be sampled annually for chemical analysis during Phase II. Moisture data from the same well network will also be collected daily during this phase. Following the completion of the initial five years of Phase II monitoring and completion of the Monitoring Report/Decision Summary for contingent remediation, it is expected that if the drain-out is occurring as predicted, the monitoring well network and sampling frequency will be reduced. The Monitoring Report/Decision Summary will present the subsequent monitoring plan for the period following the initial five years of Phase II monitoring.

3.4 Performance Standards

3.4.1 Remedial Action Objectives

The remedial action for Group 4, Perched Water, will be evaluated against the RAOs and RGs established in the WAG 3 OU3-13 ROD (ROD, Section 8). RAOs for OU 3-13 were developed in accordance with the National Contingency Plan and CERCLA RI/FS guidance. RAOs specify the contaminants and media of concern, potential exposure pathways, and RGs. RGs establish acceptable exposure levels that are protective of human health and the environment. Factors that are considered in establishing RGs are outlined in 40 CFR 300.430(e)(2)(I). RAOs are specific risk criteria that take into consideration the assumed future land uses at INTEC. The RAOs are primarily based on the results of the baseline risk assessment and ARARs.

The INTEC land use assumptions used to develop the RAOs include industrial use prior to 2095 and potential residential use after that time. Other assumptions used to develop the RAOs as listed in the ROD include:

- The INTEC facility will be used as an industrial facility up to the year 2095. During the period of DOE operations, expected to last to at least 2045, this area is a radiological control area. Only the contaminated groundwater present in the SRPA outside of the current INTEC security fence is addressed in the OU 3-13 ROD. The selected remedy is expected to fully address this contamination. However, this action does not address groundwater inside the current INTEC security fence, which will be addressed under OU 3-14.
- For the time period 2095 and beyond, it is assumed that the SRPA located outside the current INTEC security fence will be used as a drinking water supply.
- The annual carcinogenic risk at INTEC from natural background radiation due to surface elevation and background soil radiological contamination is 10^{-4} (EPA 1994, NEA 1997, UNEP 1985).
- Permanent land use restrictions will be placed on those release site source areas and the INEEL CERCLA Disposal Facility complex, which will be closed in place, for as long as land use and access restrictions are required to be protective of human health and the environment.

To achieve a reasonable degree of protection at the WAG 3 sites, the Agencies have selected a remedy for each group of sites that meet the RAOs. These remedies protect human health and the environment and meet regulatory requirements. The WAG 3 RAOs were developed for specific media (i.e. soils, perched water, or groundwater). The applicable RAOs for a particular site or group of sites depend on the specific media impacted. The RAOs listed in Section 8 of the ROD, which are directly applicable to Group 4 include (note: RAO numbering below is same as in ROD):

1. Groundwater
 - a. For INTEC-impacted groundwater (located in the groundwater contaminant plume outside of the current INTEC security fence) restore the aquifer for use by 2095 and beyond, so that the risk will not exceed a cumulative carcinogenic risk of 1×10^{-4} for groundwater ingestion
 - b. For INTEC-impacted groundwater (located in the groundwater contaminant plume outside of the current INTEC security fence) restore the aquifer to drinking water quality (below MCLs) for use by 2095 and beyond
 - c. For INTEC-impacted groundwater (located in the groundwater contaminant plume outside of the current INTEC security fence) restore the aquifer so that the noncarcinogenic risk will not exceed a total hazard index of 1 for groundwater ingestion.
2. Perched Water
 - a. Prevent migration of radionuclides from perched water in concentrations that would cause SRPA groundwater outside the current INTEC security fence to exceed a cumulative carcinogenic risk of 1×10^{-4} , a total HI of 1; or applicable State of Idaho groundwater quality standards (i.e., MCLs) in 2095 and beyond
 - b. Prevent excavations into and drilling through the contaminated earth materials remaining after the desaturation of the perched water to prevent exposure of the public to a cumulative carcinogenic risk of 1×10^{-4} , a total HI of 1; and protection of the SRPA to meet Objective 3a listed below.
3. Snake River Plain Aquifer (INTEC-derived groundwater contaminant plume outside current INTEC security fence)
 - a. In 2095 and beyond, ensure that SRPA groundwater does not exceed a cumulative carcinogenic risk of 1×10^{-4} ; a total HI of 1; or applicable State of Idaho groundwater quality standards (i.e., MCLs).

3.4.2 Remediation Goals

To meet the RAOs, RGs are established. These goals are quantitative cleanup levels based primarily on risk to human health and the environment. The RGs are based on the results of the baseline risk assessment and evaluation of expected exposures and risks for selected alternatives. If an ARAR is more restrictive, then the ARAR standard is used as the RG. The RGs will be used to assess the effectiveness of the selected remedial actions in meeting the RAOs.

The RGs for INTEC-derived COCs in the SRPA groundwater outside the current INTEC security fence are based on the applicable State of Idaho groundwater quality standards (IDAPA 16.01.011.200). The SRPA COCs consist of tritium, Sr-90 and daughters, I-129, Np-237, chromium, and mercury prior to 2095, and Sr-90, I-129, Np-237, plutonium and uranium isotopes and their daughters, and mercury in 2095 and beyond. The SRPA groundwater RGs for these COCs are presented in Table 3-2.

The RG for INTEC-derived alpha-emitting radionuclides (Np-237, plutonium isotopes and their daughters, Am-241, and uranium isotopes and their daughters) in the SRPA groundwater outside the

current INTEC security fence corresponds to a cumulative alpha-activity of 15 pCi/L in the year 2095 and beyond. WAG 3 RI/FS modeling has shown that alpha-emitting radionuclides are not expected to exceed the 15 pCi/L standard in the SRPA inside the current INTEC security fence until the year 2750, with a peak concentration occurring in the year 3804. Remediation, if necessary, of the Tank Farm inside the current INTEC security fence is expected to mitigate the future alpha-emitting radionuclide impacts in the SRPA outside the current INTEC security fence. Remediation goals for the alpha-emitting radionuclides in the SRPA inside the current INTEC security fence will be established in the final action developed in OU 3-14.

The RG for beta-gamma-emitting radionuclides (tritium, Sr-90 and daughters, and I-129) in SRPA groundwater outside the current INTEC security fence is restricted to a cumulative dose of 4 mrem/yr in the year 2095 and beyond. The RGs for chromium and mercury are 100 ug/L and 2 ug/L, respectively, for individual constituent MCLs.

Additional performance-based remediation goals were established specifically for Group 4 in Section 8.1.4 of the ROD. The perched water remediation goals are to:

- Reduce recharge to the perched zones
- Minimize migration of contaminants to the SRPA, so that the SRPA groundwater outside of the current INTEC security fence meets the applicable State of Idaho groundwater standards by 2095.

The perched water RGs are primarily designed to reduce the moisture content of the perched zone so that the contaminant transport rate in the vadose zone is reduced and radionuclide contaminants present in the perched zone have more time to naturally decay and reduce the concentration of potential contaminants released to the SRPA.

If the moisture content and contaminant flux is not sufficiently reduced as indicated by moisture content and perched water monitoring, and verified by numerical modeling, then additional infiltration recharge controls will be implemented to achieve the necessary desaturation and corresponding reduction in contaminant transport rate in the perched zone.

3.4.3 Performance Measurement Points

The Group 4 remedial action performance will be evaluated against the Group 4 RAOs and RGs discussed above. Long-term monitoring points may be changed following five years of Phase II monitoring. The current long-term monitoring points are the Phase II monitoring points.

However, because the RAOs establish that the performance criteria will be met in the year 2095 and beyond, present-day measurement of whether or not RAOs are achieved is not possible. Numerical model predictions based on vadose zone moisture content and COC concentrations trends in both the vadose zone and aquifer beneath INTEC are required to determine whether the RAO will be met in 2095 and beyond. The monitoring program for vadose moisture content and COC concentrations in both the vadose zone and SRPA is established (note: SRPA monitoring beneath INTEC will be accomplished under the Group 5 monitoring program) to support the numerical modeling. Data obtained from the soil moisture monitoring and COC concentration sampling, as well as additional data regarding stratigraphy, lithology, and other new information, will be incorporated into the WAG 3 model to periodically update the model predictions for COC concentrations in 2095. Until the year 2095, this will be utilized to determine whether the RAOs are being met.

Table 3-2. SRPA contaminant of concern remediation goals.

Contaminant of Concern	SRPA Remediation Goals (Maximum Contaminant Levels) For Single COCs		Decay Type
Beta-gamma emitting radionuclides	Total of beta-gamma emitting radionuclides shall not exceed 4 mrem/yr effective dose equivalent		Beta-Gamma
Sr-90 and daughters	8 pCi/L		Beta
Tritium	20,000 pCi/L		Beta
I-129	1 pCi/L as sole β - γ emitter, all included to demonstrate compliance against 4mRem/yr		Beta-Gamma
Alpha-emitting radionuclides	15 pCi/L total alpha emitting radionuclides		Alpha
Uranium and daughters	15 pCi/L—this includes all α emitters except as specified in 40 CFR 141.16		Alpha
Np-237 and daughters	15 pCi/L—this includes all α emitters except as specified in 40 CFR 141.16		Alpha
Plutonium and daughters	15 pCi/L—this includes all α emitters except as specified in 40 CFR 141.16		Alpha
Am-241 and daughters	15 pCi/L—this includes all α emitters except as specified in 40 CFR 141.16		Alpha
Nonradionuclides	—		—
Chromium	100 ug/L		Not applicable
Mercury	2 ug/L		Not applicable

3.4.4 Rationale for Selection of Performance Measurement Points

Performance measurements for Group 4 are based directly on the RAOs which are presented in the OU 3-13 ROD. The RAOs take land use assumptions into consideration and are protective of human health and the environment. The primary cause for establishing the performance measurement point at the security fence of INTEC in 2095 is the land use assumption stating that the SRPA outside of the INTEC security fence will be available for residential use in 2095. For this reason, water quality outside of the INTEC security fence in 2095 and beyond must meet drinking water standards.

3.5 Group 4 Perched Water ARARs

A complete listing of applicable ARARs, including an explanation of how they will be met on this project is provided in Section 4.3 of this document.

3.6 Technical Factors of Importance in Design and Construction

3.6.1 Drilling Through Soil or Perched Water Contamination

The construction of monitoring wells inside the INTEC security fence may involve drilling through zones of soil contamination and/or perched water contamination. Well construction design for these wells must account for the possibility of cross-contamination between zones, primarily in the form of carrying down contamination during drilling or creating a pathway for contaminant migration by constructing the well. Therefore, it is critical to seal any contaminated zone encountered (any soil or perched water that is discovered above the intended completion depth) from the borehole. This will generally be accomplished by grouting and casing the contaminated zone, reducing the drill bit size, and continuing drilling to the target depth. Several casing reductions may be required for the completion of a single well.

3.6.2 Flow in the Big Lost River

Successful completion of the Phase I tracer study is contingent upon the flow in the BLR. The current schedule calls for the start of the Phase I tracer study on April 9, 2001. However, it may be necessary to delay start of the tracer study to coincide with the spring runoff event that typically reaches its peak in the BLR during mid-June each year. The Phase I schedule allows for this potential delay, or to conduct the BLR Trace during a following year.

3.6.3 Percolation Pond Relocation Schedule

The Phase I tracer study is also contingent upon flow in the percolation pond throughout the duration of the test. The schedules for both this project and percolation pond relocation (Service Wastewater Discharge Facility Project) will be coordinated to ensure that the percolation ponds are not removed from service before the Spring 2001 portion of the tracer study is completed.

4. DESIGN BASIS

4.1 Status of Record of Decision Assumptions

The bounding assumptions under which the Group 4 RD/RA activities will be performed include these assumptions that describe the limiting factors and conditions under which the RD/RA activities will be performed. These assumptions include the following:

1. Monitoring for each group will be performed as part of RD/RA and is separate from institutional controls.
2. A minimum institutional control period through the year 2095, for land-use or access restrictions required to be protective, will be implemented at all sites where contaminant concentrations exceeding allowable risk ranges are left in place. The continued need for land-use or access restrictions will be evaluated by the Agencies during each five-year review.
3. Institutional Controls prior to 2095 will consist of site-access controls, radiological-posting controls, and land-use controls as shown in Table 11-1 of the ROD.
4. Groundwater contamination in the SRPA within the INTEC security fence will be addressed under OU 3-14.
5. The overall RAO for OU 3-13 is to achieve a HI of 1.0 or less and a cumulative increased carcinogenic risk of less than 1×10^{-4} .

In addition to the general assumptions listed above, the specific assumptions for Group 4, Perched Water, include the following:

1. Perched water is not a drinking water source and is unlikely to be sustainable once manmade sources of perched water recharge are eliminated.
2. Institutional controls will be protective in preventing exposure to contaminated perched water until 2095.
3. Deed restrictions and regulatory restrictions on drilling, construction, and placement of groundwater wells in the SRPA, which are drilled through contaminated perched water, will be implemented, to be effective beyond 2095.
4. Replacement percolation ponds will be operational by December 31, 2003.
5. Perched water monitoring equipment will be installed to monitor the drain-out of the perched water bodies expected after removal of the existing percolation ponds.
6. The need for implementation of additional infiltration controls, such as lining the BLR will be determined based on data collected for five years after the existing percolation pond are relocated. Because the Agencies have not performed the analyses required to modify the BLR Channel per 40 CFR 230.10 (refer to Section 12 of the ROD), lining of the BLR will require an ESD to the ROD. Therefore, this activity is not included in this MSIP.

4.2 Summary and Detailed Justification of Design Assumptions

4.2.1 Discussion of Remedial Investigation/Baseline Risk Assessment Modeling

The OU 3-13 modeling scope included base-case predictions of flow and contaminant movement. In addition, the sensitivity of predicted contaminant migration to the parameters used to implement the conceptual model was obtained. Focus in the base-case simulations was on predicting groundwater concentrations in the year 2095 to support the 100-year risk scenario for the WAG 3 Comprehensive Baseline Risk Assessment (BRA). Simulations were performed for arsenic, chromium, mercury, Am-241, Co-60, Cs-137, H-3, I-129, Np-237, Sr-90, Tc-99, total plutonium, and total uranium originating either at the land surface (current soil inventory), or from historical waste process water discharge streams, accidental releases, and past use of the injection well. In addition, because the Test Reactor Area (TRA) facility is upgradient of the INTEC, the two primary contaminants identified in the TRA remedial investigation (RI) (Cr and H-3) were included as aquifer source terms. However, predictions for the migration of TRA contaminants were not calibrated against field data.

In order to simulate contaminant transport from surface sources through the vadose zone, and eventually through the aquifer, two conceptual models were developed. The first of these two models was parameterized to simulate the infiltration of water, and the subsequent transport of contaminants through the vadose zone. The vadose zone was conceptualized as being fully three-dimensional, with contaminants originating primarily at ground surface and infiltrating vertically as well as spreading laterally. Water and contaminant mass fluxes through the bottom layer of the vadose zone model were used as the upper boundary condition for the aquifer simulation domain. This second model (aquifer model) was also three-dimensional to account for contaminants being injected at depth from the injection well and for the mass fluxes originating at land surface. The vadose zone-aquifer contaminant system at the INTEC was simulated using the three-dimensional multiphase transient code TETRAD. This code allowed incorporation of the heterogeneous physical properties necessary to solve the vadose zone infiltration problem with the large areal and point source influxes of water and contaminants. The numerical problem was broken into a vadose zone conceptual domain and an aquifer conceptual domain because of computational hardware limitations, although in theory, the two conceptual domains could have been included in a single numerical simulation.

The subsurface of the INTEC has been extensively drilled and sampled, primarily by the USGS, in an effort to understand and monitor the movement of groundwater and contaminants beneath the INTEC. In general, the subsurface at the INTEC is typical of the INEEL as a whole and is part of a large volcanic plain of layered late Cenozoic basalt flows overlying a Rhyolitic basement. The geologic interpretation of the INTEC indicates that the lithology (i.e., fracturing, vesicles, weathering surfaces, etc.) is not continuous between the 40 wells that have been drilled at the INTEC. On the other hand, the larger-scale stratigraphic relationships between the basalt flows can be correlated horizontally between the wells. Typically, the correlation indicates that the sediment units are of variable thickness and differ in strike and dip angles. Permeability and porosity for the basalt, basalt fractures, and sedimentary interbeds differ by orders of magnitude as determined from field data.

From a hydrologic perspective, it is the change in vertical stratigraphy (and corresponding change in permeability and porosity) that controls the downward migration of water and contaminants into the vadose zone; the strike and dip of the sedimentary interbeds that allows subsurface lateral mixing of water sources to occur in the vadose zone; and the larger scale sub-horizontal stratigraphic changes (and corresponding permeability and porosity) that have a primary influence on the direction of flow and depth of mixing of contaminants in the aquifer. As a result, the stratigraphy plays a primary role in the hydrologic description of the INTEC. Therefore, the sedimentary interbeds in the vadose zone were represented using three dimensional kriged values for thickness and extent, as discussed in Section 2.2.3.2

of Appendix F of the Remedial Investigation/Baseline Risk Assessment (RI/BRA) report (DOE-ID 1997a).

The other primary hydrologic control at the INTEC is presented by the numerous high-volume surface water recharge sources. There are eight broad categories of water sources distributed throughout the surface and shallow subsurface of the INTEC. These include natural infiltration (558,960 kg/day), water system leaks (41,277 kg/day), landscape irrigation (13,500 kg/day), steam condensate (17,332 kg/day), the CPP-603 infiltration basins (511 kg/day), sewage treatment ponds (155,565 kg/day), service wastewater sent to the percolation ponds (5,838,868 kg/day), and the BLR (2,696,458 kg/day). Of these surface water sources, the service wastewater discharges and BLR are the primary contributors to infiltration and are located in the south and to the northwest of the INTEC facility, respectively. The complex stratigraphy combined with the high-volume water sources results in variably saturated flow in the vadose zone where regions of very low water saturation (approaching zero) are found in the basalt and where water saturations approach unity throughout many of the sedimentary interbeds. Within these sedimentary interbeds and interlayered basalts, water originating in the north mixes with water originating in the south. Flow in the subsurface of the INTEC occurs in a subhorizontal direction as well as infiltrating vertically. This phenomenon explains why the vadose zone conceptual model was, of necessity, three-dimensional. Justification for the three-dimensional aquifer model is similar, and is based on both stratigraphic variability and vertical variability of the sources of contaminants entering the aquifer.

Fundamental parameters necessary to solve the vadose zone and aquifer water and contaminant transport problems include permeability relationships (saturated permeability for air and water, permeability-saturation curves, capillary pressure-saturation curves), porosity, dispersivity, and soil-contaminant partitioning relationships. These parameters need to be assigned for each different stratigraphic or lithologic unit incorporated by the conceptual model. In addition, the model requires boundary conditions in the form of either prescribed pressure or prescribed flux. A surficial summary is included below.

Vadose Zone Model. Hydraulic parameters for the transient vadose zone infiltration and transport model include saturated permeability for air and water, moisture characteristic relationships describing the constitutive relationships between capillary pressure-saturation and relative permeability-saturation, porosity, dispersivity, and parameters describing (in this specific case) matrix-contaminant adsorption. These parameters were assigned for the sedimentary units (alluvium and effective interbeds) and for the basalt fractures. Values for the basalt matrix were not assigned based on results of a previous modeling study conducted for the Large Scale Infiltration Test (LSIT) by Magnuson (1995). Reasons for neglecting the matrix contribution are given by Magnuson (1995) and are discussed in Appendix F of the RI/BRA. Neglecting the contribution of the basalt matrix is based on simulations examining the relative contribution of basalt matrix (high porosity, low permeability) and basalt fractures (low porosity, high permeability) for a large field-scale infiltration test conducted at the INEEL. The simulation results indicated that the contribution of basalt matrix in the dual porosity formulation was negligible and that adequate matches to field data could be obtained considering only the basalt fractures and sediments in a single porosity formulation.

For this modeling, it was assumed that the basalt characteristics determined from the LSIT modeling (Magnuson 1995) were essentially appropriate for the INTEC basalts. Based on Magnuson's results, it was assumed that the basalts could be treated as an anisotropic "single porosity" media (that is, neglect the matrix and only simulate the fracture network), with a horizontal and vertical fracture permeability of 90,000 mD and 300 mD, respectively, and a basalt fracture effective porosity of 5%. Unsaturated moisture characteristic curves for the fractured material were discussed in Appendix F of the RI/BRA. The sediment characteristics at the INTEC were slightly different than those observed during

the LSIT test, primarily because of the distribution and thickness of clay content. Thus, the sediment permeability was used as a calibration parameter, and results based in values ranging from 78 mD to 4 mD were obtained. Porosity for the sediments was also a calibration parameter.

The final parameter is based on tabulated constitutive parameters. Additional parameters used were: (a) saturated water permeability of 4 mD (isotropic) in the sedimentary interbeds, (b) an isotropic alluvium permeability of 78 mD, (c) basalt fracture permeability of 90,000 mD horizontally and 300 mD vertically, and (d) sediment porosity of 48.7% and basalt fracture porosity of 5%.

Aquifer Model. Hydraulic parameters for the transient aquifer transport model include saturated permeability for water, porosity, dispersivity, and parameters describing (in this specific case) matrix-contaminant adsorption. There were four distinct stratigraphic types identified as playing a primary role in the transport of contaminants through the aquifer. These included an upper I basalt unit, a lower I basalt unit, the HI interbed, and the H basalt unit. Estimates of permeability for the I basalt region, wells local to the INTEC, and regional estimates of hydraulic conductivity formed the database for aquifer hydraulic values. The I basalt unit was assigned permeabilities representative of those obtained in the INTEC pumping and injection wells. Larger-scale regional permeabilities were taken from the WAG 10 modeling effort (McCarthy et al. 1995). Local scale INTEC permeabilities are consistent with the INTEC well test results. Hydraulic parameters were assigned to the model grid based on the area in which the stratigraphic units appeared as discussed below.

The hydraulic conductivities used in the aquifer model were first interpolated onto the WAG 3 model grid from the final values determined from a WAG 10 regional groundwater flow model. The WAG 10 model used an Eastern Snake River Plain regional water balance to define the boundaries in order to ensure a water mass balance through the Eastern SRPA. WAG 10 hydraulic conductivities ranged from 85,000 to 1,530,000 mD and were comparable in magnitude to the local INTEC values. Because of this similarity, the WAG 10 conductivities were believed to provide reasonable larger-scale values for long-term transport predictions for this INTEC model.

The upper I basalt unit, lower I basalt unit, and HI interbed are the dominant stratigraphic features in the saturated zone. The upper I basalt flow and lower I basalt flow differ hydraulically because the I basalt flow dips steeply near the north to northwest boundary of the INTEC model domain. This dip means that the top of the I basalt flow is probably more highly fractured and thus exhibits higher permeability, with the permeability decreasing in the flatter regions to the south. Distinguishing an upper and lower I basalt region was done by assigning a value representative of the CPP-01, CPP-02, and CPP-03 wells to the upper I basalt region, and assigning one-half of the lowest WAG 10 INTEC permeability ($8.5E4$ mD) to the lower I basalt region. These values replaced the WAG 10 permeabilities in grid blocks containing the I basalt flow. To be consistent with the sediment properties used in the vadose zone, permeability of 4 mD was assigned to the first layer of grid blocks overlying the I basalt flow. Assigning sediment properties uniformly over the I flow assumed that the HI interbed was 7.6 m thick and existed everywhere the I basalt flow exists. The final level of refinement for hydraulic conductivities in the INTEC aquifer model incorporated INTEC local scale field data. These local scale hydraulic conductivities above 90,000 mD were applied throughout the vertical profile defined by the footprint of the vadose zone model. The 90,000 mD cutoff limit was used based on observations made during the transport calibration phase.

4.2.2 Assumptions

The Comprehensive RI/FS for the INTEC (DOE-ID 1997a) identifies several key assumptions used in the development of the modeling effort. The assumptions are described below:

- That the basalt characteristics determined from the LSIT performed by S. O. Magnuson (1995) are also appropriate for the INTEC basalts. Based on Magnuson's results it was assumed in all simulations that the basalts can be treated as an anisotropic "single porosity" media. It was assumed that the material beneath the INTEC will behave as did the material under the LSIT.
- In order to be consistent with Magnuson (1995), a horizontal and vertical fracture permeability of 90,000 mD and 300 mD, respectively, and an effective porosity of 5% has been applied to the vadose zone model. In addition, the presence of preferred flow channels is highly probable, as is the idea that they form the dominant transport paths in the basalts beneath the INTEC.
- A steady-state contribution to infiltration has been assumed for the BLR.
- With the exception of the percolation pond areas, the precipitation contribution is assumed to be the largest areal mass flux.

4.2.3 Aquifer Modeling Results

The simulations of COC transport from their various sources through the vadose zone to the aquifer are summarized in Section 6 of the OU 3-13 RI/BRA. By the year 2025, the chemical concentrations of chromium and total uranium will be below their HQ=1 based concentration and the Co-60 concentration will be below its 10^{-6} risk-based concentration. By the year 2095, the concentrations of H-3, total plutonium, and Tc-99 will be below their 10^{-6} based concentrations. Chromium, Co-60, H-3, and Tc-99 concentrations will all continue to decrease in the future. Total uranium and total plutonium concentrations will increase in the future. Of the remaining COCs, the aquifer concentrations of Cs-137, I-129, mercury, Np-237, and Am-241 will all decrease after 2095 and the concentrations of arsenic and Sr-90 will increase. After the year 2095, the arsenic increase is predicted to be minor but the total plutonium (factor of 250), Sr-90 (factor of 2), and total uranium (factor of 10) increases are predicted to be significant.

Institutional controls have been assumed to be in place until the year 2095. Of particular interest are the peak groundwater concentrations after the institutional control period. These peak concentrations and the timing of the peaks are shown in Table 6-8 of the RI/BRA. In the year 2095, peak concentrations in the aquifer are predicted to be decreasing for chromium, Co-60, Cs-137, H-3, I-129, mercury, Np-237, Tc-99, and Am-241. However, aquifer peak concentrations are predicted to rise after the year 2095 for Sr-90 (until year 2172), uranium (until year 2468), arsenic (until year 4279), and plutonium (until year 3585).

4.3 Evaluation of Compliance with Applicable or Relevant and Appropriate Requirements

Table 4-1 contains a list of the ARARs identified in the ROD for the work to be conducted under this MSIP for Group 4. These ARARs were identified as action-specific, chemical-specific, and To Be Considered (TBCs); no location-specific ARARs were identified. Table 4-1 lists the ARARs, as well as the specific action that will be taken to ensure the ARARs are met.

4.4 Plans for Minimizing Environmental and Public Impacts

One of the general purposes of the FFA/CO is to “expedite the cleanup process to the maximum extent practicable consistent with protection of human health and the environment.” The parties to the FFA/CO intended that any response action selected, implemented, and completed under the Agreement will be protective of human health and the environment such that remediation of releases covered by the Agreement shall obviate the need for further response action.

Every effort has been made in the planning of this project to utilize well-established and available processes and guidance, and achieve compliance with CERCLA and Resource Conservation and Recovery Act processes. Special consideration will be given to the disposition of dangerous or emergency conditions. If a dangerous or emergency condition is discovered that may pose “imminent and substantial endangerment to people or the environment,” personnel have the authority to stop work per FFA/CO Section 29.

Table 4-1. Compliance with ARARs for Group 4, Perched Water, selected remedy.

Alternative/ARARs citation	Description	Applicable, or Relevant and Appropriate (R&A), or TBC	Comments
Group 4—Perched Water: Alternative 2—Institutional Controls with Aquifer Recharge Control			
<i>Action-specific</i>			
IDAPA 16.01.05.008 (40 CFR 264.14)	Site security	Applicable	The project site is located within the INEEL, which has restricted access.
40 CFR 230.10 and 11	Substantive requirements of 404(b)(1) specifications of disposal sites for dredged or fill material	Applicable	This project will not modify the Big Lost River Channel.
Executive Order 11990	Protection of wetlands	Applicable	This project will not affect any wetlands.
Executive Order 11988	Floodplain management	Applicable	This project will not modify the Big Lost River Channel.
Rivers and Harbors Act	Section 10 of the Rivers and Harbors Act of 3 March 1899	Applicable	This project will not modify the Big Lost River Channel.
IDAPA 37.03.09	Idaho Well Construction Standards	R&A	Wells will be constructed according to the requirements of the IDAPA 37.03.09
IDAPA 16.01.05.008 (40 CFR 264.114)	Disposal or decontamination of equipment, structures, and soils	Applicable	Equipment will be decontaminated and screed prior to release. Soils will be disposed of per the soils strategy outlined in the IC plan. No structures will be affected by this project.
IDAPA 16.01.01.650, 16.01.01.651	Idaho Fugitive Dust Emissions	Applicable	Dust suppression measure will be implemented as necessary during the drilling and sampling events to minimize the generation of fugitive dust and restrict the potential spread of contamination. These measures may include water sprays,

Table 4-1. (continued).

Alternative/ARARs citation	Description	Applicable, or Relevant and Appropriate (R&A), or TBC	Comments
			minimizing vehicle speeds, and work controls during periods of high winds.
IDAPA 16.01.01.585, 16.01.01.586	Rules for the Control of Air Pollution in Idaho	Applicable	It is not anticipated that this project will generate any air emissions of significance.
40 CFR 61.92, 61.93	NESHAPS for Radionuclides from DOE Facilities, Emission Monitoring and Emission Compliance	Applicable	If radioactive contamination is encountered, analytical data will be collected to quantify the amount of activity released. Appropriate actions will be taken to ensure compliance.
IDAPA 37.03.07.030	Idaho stream channel alteration rules	Applicable	This project is not expected to impact the Big Lost River.
IDAPA 16.01.05.008 (40 CFR 264.533)	Temporary units	Applicable	Temporary tankage may be used to collect drill cuttings and purge water. These tanks will be collected and put into a CERCLA Storage Area.
IDAPA 16.01.05.008 (40 CFR 264.554)	Remediation waste staging piles	Applicable	Any staging piles will be constructed to prevent infiltration and wind erosion by covering.
<i>Chemical-specific</i>			
IDAPA 16.01.05.006 (40 CFR 262.11)	Hazardous waste determination	Applicable	Waste generated as a result of remediation will be handled according to the project-specific Waste Management Plan.
10 CFR 20 Appendix B, Table 2	Annual limits for radionuclides effluent concentrations	R&A	This project will not place any material into the Big Lost River.
<i>Location-specific</i>			
None identified			

Table 4-1. (continued).

Alternative/ARARs citation	Description	Applicable, or Relevant and Appropriate (R&A), or TBC	Comments
<i>TBCs</i>			
DOE Order 435.1	Radioactive waste management performance objectives to protect workers	TBC	In addition to the project specific Health and Safety Plan, a Job Safety Analysis and/or radiological permit(s) will be prepared for the tasks where there is potential for exposure to radioactive contamination/materials, to protect human health and the environment. Radiological work permits will only be used as determined by the radiological controls technician, based on the INEEL Radiological Manual (Manual 15a). Radioactive waste generated during the project will be managed according to the project-specific Waste Management Plan.
DOE Order 5400.5	Exposures to the public will be kept as low as reasonably achievable	TBC	In addition to the project-specific Health and Safety Plan, a Job Safety Analysis and/or radiological permit(s) will be prepared for the tasks where there is potential for exposure to radioactive contamination/materials, to protect human health and the environment. Radiological work permits will only be used as determined by the radiological controls technician, based on the INEEL Radiological Manual (Manual 15a). Radioactive waste generated during the project will be managed according to the project specific Waste Management Plan.

5. REMEDIAL DESIGN

This section outlines the activities that will be performed to meet the RAOs and RGs set forth in the ROD.

5.1 Phase I Well Installation and Sampling

In Phase I, wells and vadose zone instrumentation will be installed near three defined recharge locations: (1) the Percolation Ponds (before they are relocated), (2) the BLR, and (3) the sewage treatment lagoons. These well sets will be used in the performance of the tracer test(s). Each of these Phase I well sets will include an alluvial well (with instrumentation installed at approximately 45 ft bgs), an upper perched water well (with instrumentation installed at approximately 120 ft to 140 ft bgs), and a lower perched water well (with instrumentation installed at approximately 380 ft bgs). In addition to the above well sets, a fourth set will be installed in a central location between the percolation ponds and the tank farm (with instrumentation placed in the shallow and deep perched zones). A fifth well set will be installed near the northwest corner of the tank farm with instrument installation in the alluvium shallow perched zone, deep perched zone, and in the SRPA.

Instrumentation in Phase I perched water wells will include a piezometer, tensiometers (to measure soil tension), suction lysimeters (for collecting water samples), and moisture sensors. The piezometer will be installed in the borehole at the primary perched water zone. The suction lysimeters will be installed in the primary perching zone and other “wet” zones as defined after drilling and geophysically logging the deepest hole in a specific set. Lysimeter placement in the well at the primary perched water zone will allow for continued contaminant sampling as the saturation level decreases. The Phase I perched water wells are also discussed in the FSP, Appendix B.

Phase I will also include collecting soil moisture tension data from the Phase I perched water wells, collecting water samples from lysimeters in newly installed and existing perched water wells, and analyzing data for COCs and water geochemistry. COC analytes include tritium, technetium-99, iodine-129, strontium-90, plutonium isotopes (Pu-238, -239, -240, -241) uranium isotopes (U-234, -235, -238), neptunium-237, cesium-137, and mercury. In addition to the COCs listed in the ROD, sewage and other hazardous constituents will be initially analyzed for and include 1,1,1-TCA, carbon tetrachloride, TCE, PCE, benzene, toluene, and carbon disulfide. Several Isotopic Ratios will be evaluated along with the constituents listed above if an independent research project receives funding. The Isotopic Ratios of nitrogen, oxygen, strontium, and hydrogen have been identified for this research. Final notification of funding will be made near the end of FY 2000. Water level data will also be collected from existing INTEC perched water wells.

5.1.1 Drawings and Specifications

This section outlines the specifications for the information that can be used to show that the RAOs have been met. Drawings of the proposed instrument installations are also shown and discussed in this section.

5.1.1.1 Specifications. This subsection covers the methods and materials that will be used in the successful completion Phase I work. Each well set will be drilled with a combination of rotary and wire-line coring. The deepest hole in each well set will be drilled first, with continuous core collection from ground surface to total depth. Coring operations will start with a PQ-size wire-line core barrel. As perched zones are encountered, they will be cased off and the core barrel size reduced accordingly to prevent contaminant movement to lower, possibly cleaner, perched zones. Additional details on the

drilling and sampling to be done during Phase I can be found in the FSP for OU 3-13, Group 4, Perched Water, Well Installation.

Table 5-1 shows the four types of wells, expected completion depths, instrumentation, and expected final borehole size for the given completion depth. The final borehole sizes shown reflect the diameter of the borehole the completion depth. Depending on the total well depth, the initial size of the borings may be up to 61 cm (24 in.) to allow for all of the necessary casing reductions to reach the target depth while sealing off zones of perched water.

Upon reaching the target depth, each borehole will be geophysically logged. At a minimum, this logging will consist of video, caliper, natural gamma, deviation, gamma-gamma, neutron, density, isotopic analysis of anomalous (high activity) areas, and high-resolution gamma spectroscopy. All geophysical logs will be used for comparison of information and to assist in the field determination of instrument placement. Down-hole logging will be performed by the INEEL field office of the USGS and Bechtel BWXT Idaho, LLC (BBWI) personnel.

Upon completion of down-hole logging, the open boreholes will be equipped with instrumentation to provide for long-term monitoring of vadose zone moisture and the collection of pore water samples. Results of the well logging will be used to determine the exact placement of the instrumentation. It is anticipated that each borehole will be equipped with a minimum of two tensiometers, one suction lysimeter and one moisture sensing device. Instrumentation will be installed in the target perched water zones and other “wet” zones as identified by the geophysical logs.

Piezometers will be installed in the alluvium, shallow, and deep perched water zones. Well screens will be placed in zones identified during the drilling and geophysical logging that are identified as water bearing, or “wet,” zones. Well completion information can be found in Appendix B, the FSP for Group 4 well installation.

Wells will be developed after completion; however, the criteria and method for development will be determined in the field based on the available water in each well. Wells with significant amounts of water will be developed in the same manner as aquifer wells. It is anticipated that some wells will have only a couple of inches of water so that full well development cannot be performed. The FSP (DOE/ID-10745, 2000) contains details of well development procedures.

5.1.1.2 Proposed Well Locations. Figure 5-1 shows the proposed locations for the Phase I and Phase II wells and existing wells.

5.1.1.3 Well Instrumentation Diagrams. Figure 5-2, 5-3a, 5-3b, and 5-3c show typical aquifer well and perched zone instrument installation.

5.1.1.4 Chemical and Geotechnical Data. Table 5-2 lists the hydraulic and chemical data to be gathered from each well set during the Phase I work.

Table 5-1. Phase I well completion approximate depths, borehole diameter at the completion depth, and possible instrumentation.

Well Type	Expected Completion Depth (ft bgs)	Expected Diameter of Borehole	Instrumentation
Alluvium	45	6 in.	Tensiometer and lysimeter
Shallow perched	120–140	6 to 12 in.	Moisture sensor, tensiometer, lysimeter
Deep Perched	380–400	6 to 12 in.	Moisture sensor, tensiometer, lysimeter
Aquifer	480–520	10 to 12 in.	Pressure Transducer

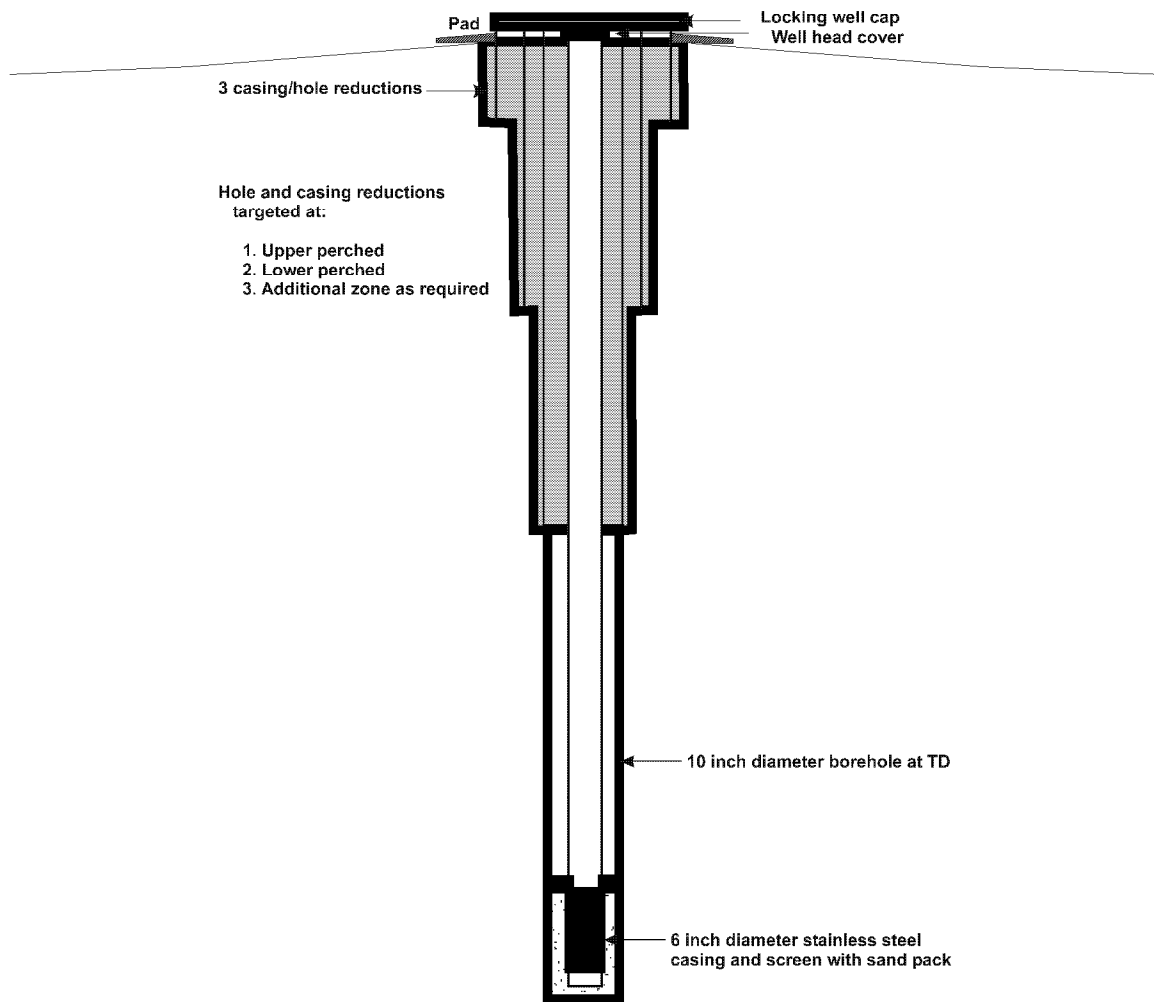


Figure 5-2. Conceptual diagram for aquifer well completion.

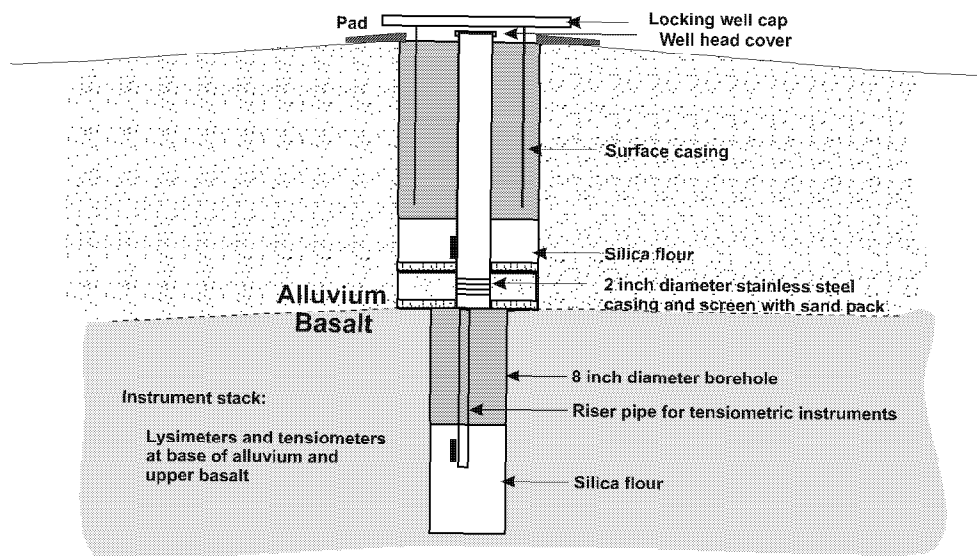


Figure 5-3a. Conceptual diagram for alluvium zone instrument installation.

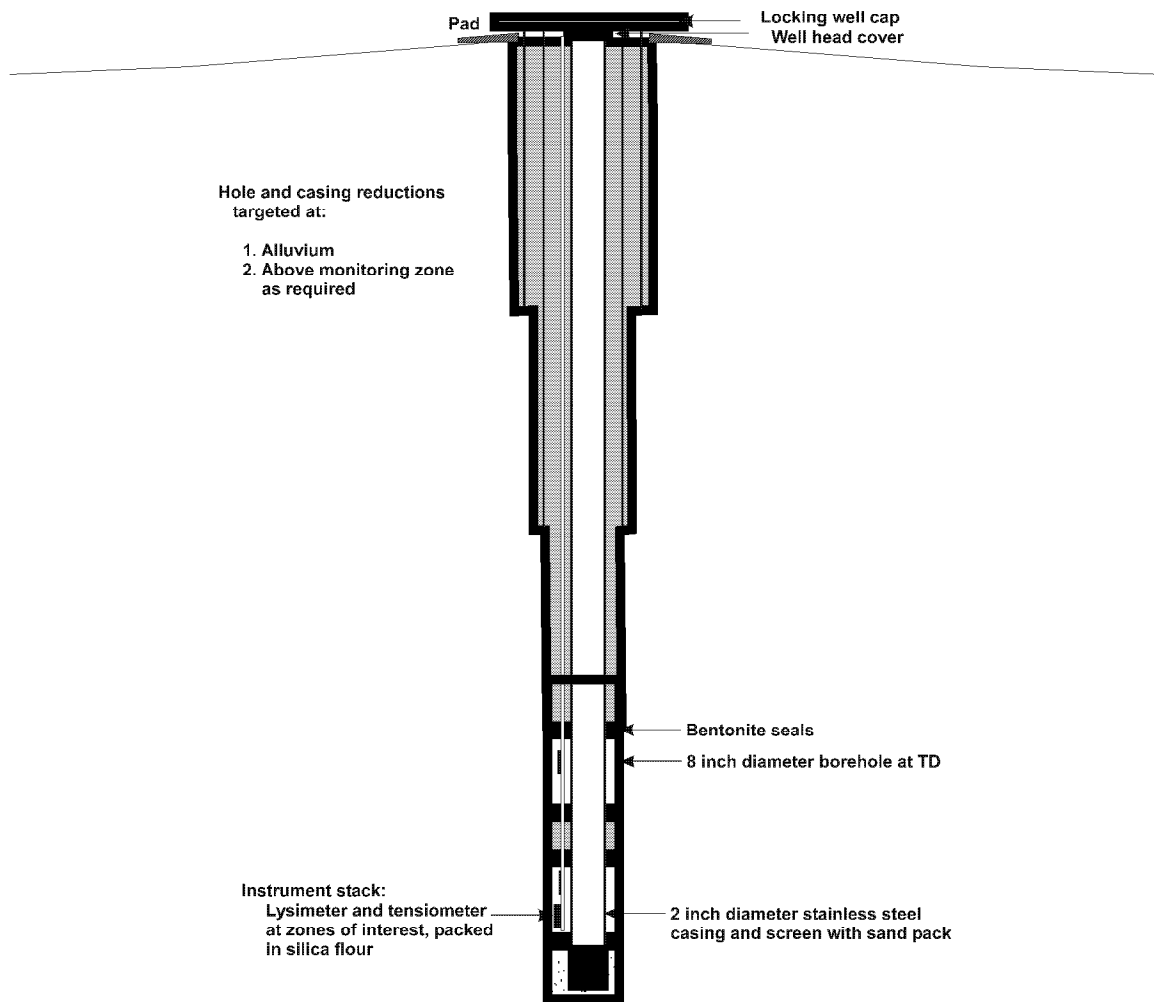


Figure 5-3b. Conceptual diagram for shallow perched water zone instrument installation.

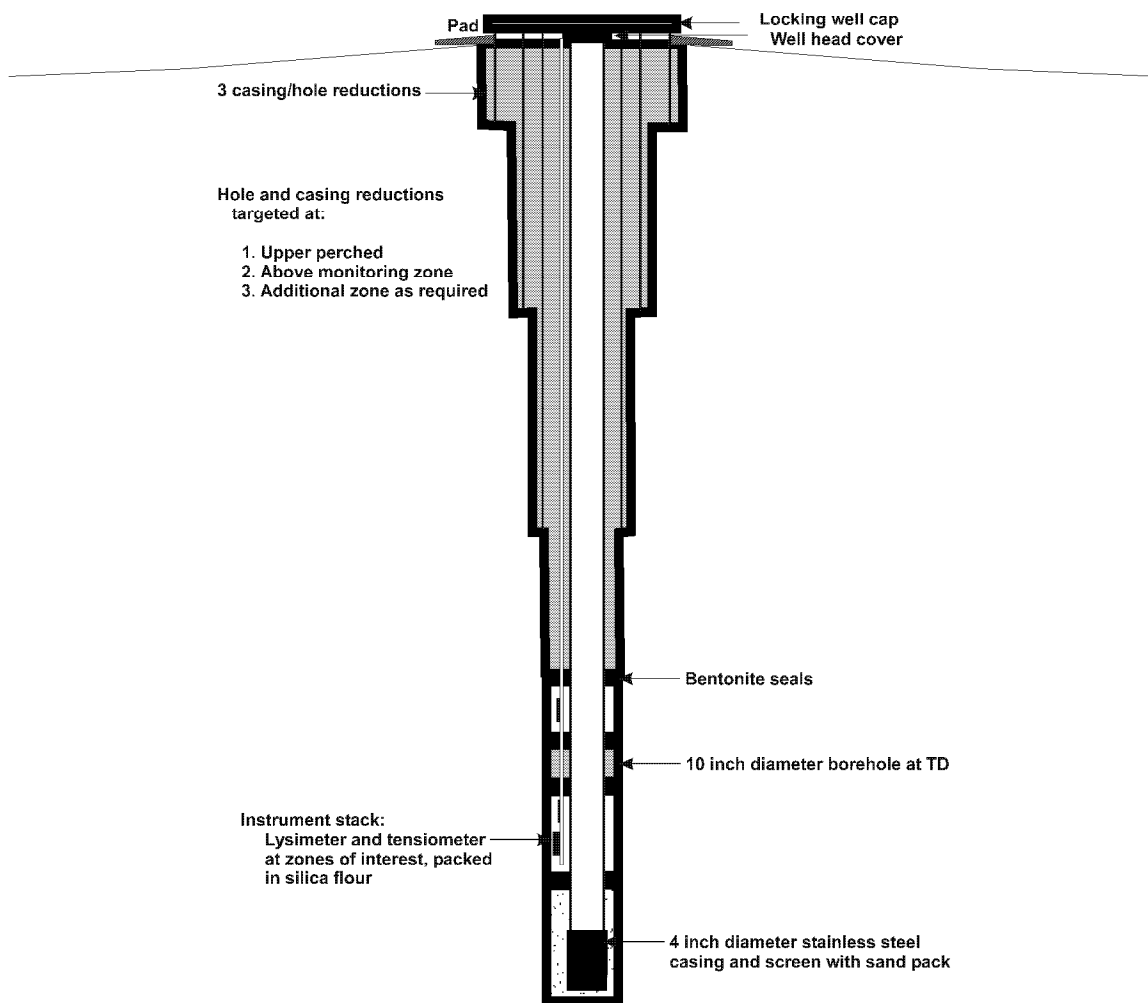


Figure 5-3c. Conceptual diagram for deep perched water zone instrument installation.

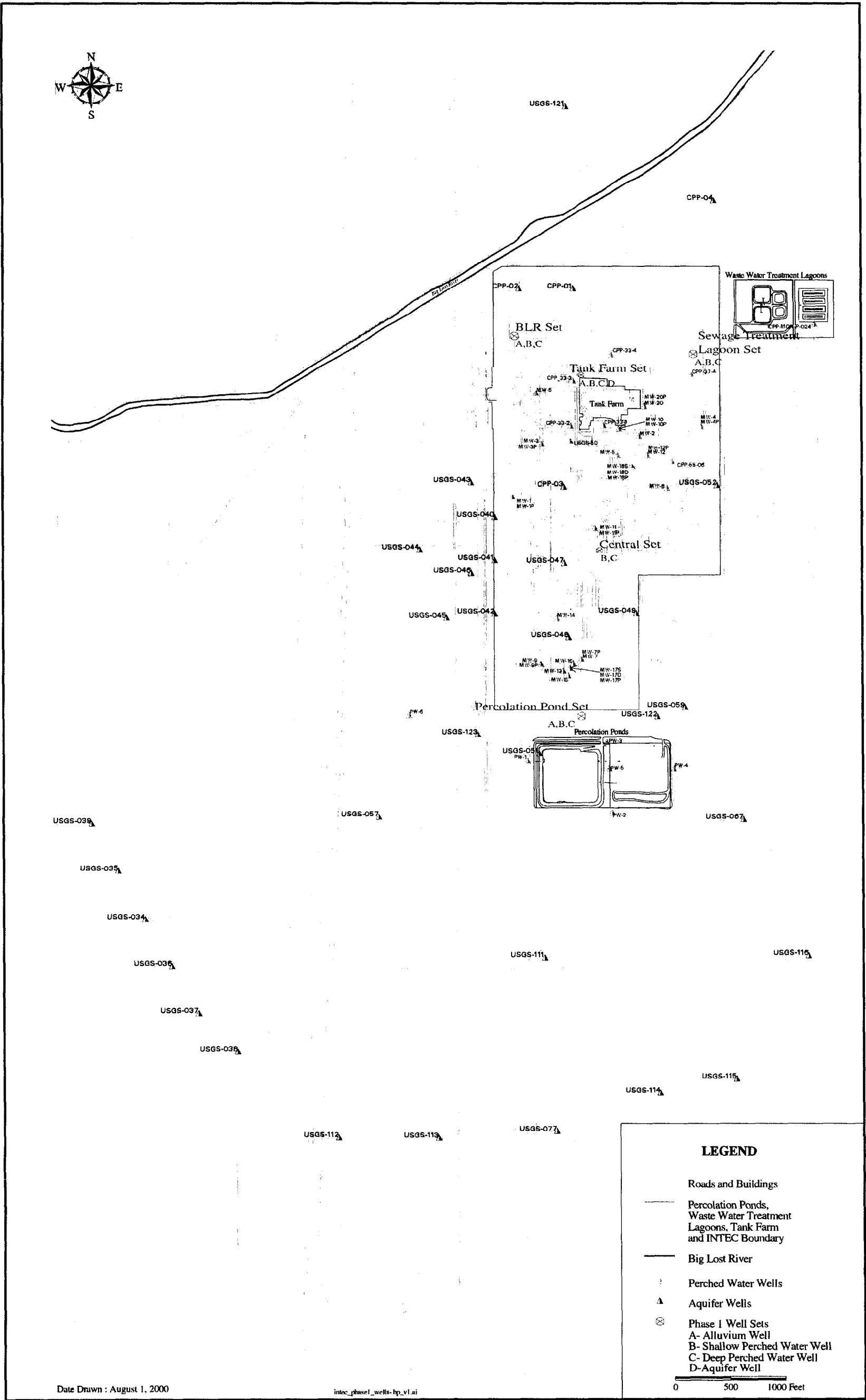


Figure 5-4. INTEC area map showing locations of proposed sampling stations.

Table 5-2. Phase I and initial Phase II chemical and geotechnical data collection.

Cations	Anions	COCs	Hazardous Substances	Field	Conditional ^a	Geotechnical	Geophysical
Calcium	Sulfate	Tritium	1,1,1-TCA	Temperature	Nitrogen Isotope Ratio	Bulk Density	Video
Magnesium	Chloride	Technicium-99	Carbon Tetrachloride	pH		Grain Size	Caliper
Sodium	Bromide	Iodine-129	TCE	Alkalinity	Oxygen Isotope Ratio	Porosity	Natural Gamma
Potassium	Fluoride	Strontium-90	PCE	Dissolved Oxygen		Moisture Content	Deviation
Strontium	Nitrite	Plutonium isotopes (Pu-238, -239, -240, -241)	Benzene	Specific Conductivity	Strontium Isotope Ratio	Moisture Characterization Curve	High Resolution Gamma Spectroscopy
Antimony							
Arsenic							
Boron	Nitrite	Uranium isotopes (U-234, -235, and -238)	Toluene		Hydrogen Isotope Ratio	Saturated and Unsaturated Hydraulic Conductivity	
Beryllium							
Cadmium							
Chromium	Phosphate	Am-241	Carbon Disulfide			Permeability	Gamma-Gamma
Lead		Np-237	Pyridine			Field Capacity	Density
Silver		Ce-137					Neutron
Thallium		Mercury					

a. These analyses are conditional upon receipt of research funding for a separate study. Should the research grant be funded these analyses will be conducted.

5.2 Phase I Tracer Study

The tracer test is a component of the Group 4, OU 3-13, post-ROD Phase I investigation. Development of the tracer test is based on the data requirements identified in the OU 3-13 Group 4 DQOs. The groundwater tracer study will focus on developing data to define flow conditions from the major recharge sources to the INTEC perched water and SRPA. The objectives for the tracer are listed below:

- Determine the flow conditions between the major recharge sources, the perched zones beneath the site, and the SRPA
- Determine travel time to the perched water zones and to the SRPA
- Determine contributions that the major recharge sources make to the perched aquifers beneath the site
- Determine the degree of mixing of recharge waters reaching the perched zones beneath the site.

5.2.1 Drawings and Specifications

This section outlines the specifications for the information that will be used to perform the tracer test.

5.2.1.1 Specifications. The specifications for the tracer test design are summarized in the following items.

The tracer test design is summarized below.

1. Three different dyes will be used in the study. Each will be introduced in a different area to help characterize water movement from surface water resources into the perched aquifer and ultimately into the SRPA.
 - a. Dye Introduction 1 (percolation ponds) will use eosine dye. The dye introduction will be made in one of the percolation ponds. This dye introduction is designed to assess water movement into the perched aquifer from the percolation ponds. Dye Introduction 1 will take place in Spring 2001, regardless of flow conditions along the BLR recharge source.
 - b. Dye Introduction 2 (sewage treatment ponds) will use rhodamine WT dye. The dye introduction will be made in one of the trenches into which treated wastewater is discharged. This dye introduction is designed to assess water movement into the perched aquifer from the wastewater treatment plant. Dye Introduction 2 will take place in Spring 2001, regardless of flow conditions along the BLR.
 - c. Dye Introduction 3 (BLR) will use fluorescein dye. The exact area into which the dye will be introduced will depend upon hydrologic conditions. If the BLR is not flowing, then water will be pumped from one of the production wells into the river channel and dye will be introduced into the channel. The rate of water introduction will be such that flow in the channel does not extend beyond point in the river about 1600 feet downstream of the northwest corner of INTEC. The upstream end of water and dye

introduction will be a point in the channel of the BLR approximately 800 feet upstream of the northwest corner of INTEC. If the BLR is flowing at the time the dye is to be introduced, then the dye introduction will be made into a ditch constructed along the dirt road that parallels the BLR and is on the south side of the river. The ditch will be constructed by either excavating the ditch into native soils or by creating a system of berms (possibly with sand bags) atop the native soils in order to contain the necessary dye and water. The construction of the bermed surface impoundment allows flexibility in dye introduction if it is determined that excavation along the BLR is inappropriate owing to the presence of archaeological site or other sensitive areas along the river. This dye introduction is designed to assess water movement into the perched aquifer from the BLR.

2. If Option A (Figure 5-5) is chosen as the appropriate testing circumstances, dye Introductions 1 and 2 will be made on the same day. Dye Introduction 3 will be made about three weeks after Dye Introductions 1 and 2. This is done because there is a possibility that Dye Introduction 3 might yield a small amount of dye to one of the production wells. If this were to occur, there might be a small amount of dye from Dye Introduction 3 discharged to the areas used for Dye Introductions 1 and 2. A three week time separation will insure that dye recoveries can be associated with particular dye introduction locations.
3. If Option B (Figure 5-5) is selected, only Dye Introductions 1 and 2 will be carried out during Spring 2001. Dye Introduction 3 will be carried out under Phase II testing sometime between 2002 and 2006 according to Figure 4-1 (Option C).
4. Sampling for the tracer dyes will place primary reliance upon activated carbon samplers with secondary reliance upon water grab samples. The activated carbon samplers are continuous and accumulating samplers that are highly effective in determining whether or not dye reached a particular sampling station during the interval between sampling events.
5. Sampling stations for the study will include wells that intersect the perched aquifer, wells that intersect the SRPA, and control stations. There will be a total of 99 sampling stations. There are 22 perched aquifer wells that are likely to contain water at the time of the tracing study plus 9 additional perched aquifer wells that will be drilled prior to the tracing test and will likely contain water during the tracing test. There are 23 perched aquifer wells that are unlikely to contain water at the time of the tracing study but will be sampled on a limited basis if some of them do contain water during the study. There are 40 deep aquifer wells (one that is reportedly dry) that will be sampled during the study. Finally, there are 5 control stations that will be sampled. The total number of sampling stations where water is expected to be encountered during the study is 75. There are 24 additional wells where water is not expected to be encountered during the study; these will be sampled on a limited basis.
6. During 1995, the BLR started to flow after a long period of no flow. There were almost instantaneous water level responses in five wells in the shallow perched aquifer. These will be monitored for the period from about one week before any dye introduction to about three weeks after the last dye introduction with automatic water samplers programmed to collect water samples every 8 hours. These are wells 33-4, 37-4, 55-06, MW-2, and MW-4. Well 33-4 is upgradient and MW-2 and 55-06 are downgradient of the Tank Farm, assuming local groundwater flow toward the southeast, while wells 37-4 and MW-4 are northeast of the Tank Farm and likely cross-hydraulic gradient. After the end of the period when automatic pumped samplers are used, these wells will be monitored in the same fashion as other monitoring wells containing water, as discussed in the Tracer Test Plan (DOE/ID-10762).

7. MW-17S and MW-15 are located near the percolation ponds. These two wells will be monitored from about one week prior to any dye introduction to about three weeks after the last dye introduction with automatic water samplers programmed to collect water samples every 8 hours. After the end of the period when automatic pumped samplers are used, these wells will be monitored in the same fashion as other monitoring wells containing water.
8. Weekly background sampling for the presence of fluorescence dyes or compounds with similar fluorescence characteristics will be conducted for about three weeks prior to any dye introduction. During the background sampling, any dye or compound with fluorescence compound with characteristics similar to one of the dyes will be quantified as though it were the dye. One criterion for a positive dye recovery after dye introduction is that the concentration must be at least an order of magnitude greater than the maximum concentration detected in any background sample from the sampling station in question.
9. The anticipated duration of the tracer study is 25 weeks. However, given the uncertainties regarding tracer travel times, it is possible that the test may be lengthened to accommodate collection of additional data after the 25-week limit. At approximately the 22nd to 23rd week of the tracer study, a preliminary evaluation of the data will be performed to evaluate the need to lengthen the test. If the test is extended, the monitoring network will also be evaluated to eliminate wells that are no longer providing useful data from the sampling network. The study duration may be increased or shortened if certain conditions are met, upon approval by the Agencies. The intent is to time the start of the test with maximum flow in the BLR (spring runoff).
10. Dye analysis work will use a Shimadzu RF5301 Spectrofluorophotometer based at the INEEL to ensure that samples do not leave the facility, due to possible contamination. The raw data will be submitted to the Ozark Underground Laboratory (OUL) on disk for processing and analysis.
11. This dye tracing study plan permits sufficient flexibility to make logistical adjustments necessitated by field conditions, equipment problems, personnel availability, and other unforeseen events.

5.2.1.2 Drawings. Figure 5-4 shows a map of the INTEC facility showing control and monitoring stations that will be used to monitor the tracer test.

5.3 Phase II Activities

The Phase II wells will be installed to provide moisture monitoring and COC sampling locations for monitoring the perched water drain-out and contaminant flux to the SRPA. All well sets will contain at least three wells, one to be completed in the upper perched water zone, another to be completed in the lower perched water zone, and a third to be completed in the SRPA.

The aquifer skimmer well will be screened across the water table so that the screen will be set slightly below the SRPA water table (~140 m [460 ft]). The SRPA skimmer well will be used for sampling SRPA water to determine contaminant flux originating in the vadose zone. Placement of these wells will be primarily around the Tank Farm; however, placement of the Phase II wells may be refined, based on the results of the Phase I activities.

Phase II perched water wells will be instrumented similar to the Phase I wells and will include tensiometers (to measure soil tension), suction lysimeters (for collecting pore-water samples), and piezometers. Piezometers will be placed if significant perched water is encountered to allow for water

WAG 3 Group 4 Tracer Test Logic

	Scenarios	
	BLR Flowing	BLR Not Flowing
Percolation Ponds in Use	Option A	Option B
Percolation Ponds Not in Use	Option C	

Assumptions and Definitions:

- 1) Relocate Percolation Ponds in 2002.
- 2) Cannot know, apriori, if BLR will flow in any given year.
- 3) Sewage Treatment Lagoons operational for all scenarios listed.
- 4) Option A = inject tracer in perc. ponds, BLR, and sewage lagoons.
- 5) Option B = Inject tracer into perc. ponds and sewage lagoons only.
- 6) Option C = inject tracer into BLR, with the possibility of injecting into any other potential sources subsequently identified.

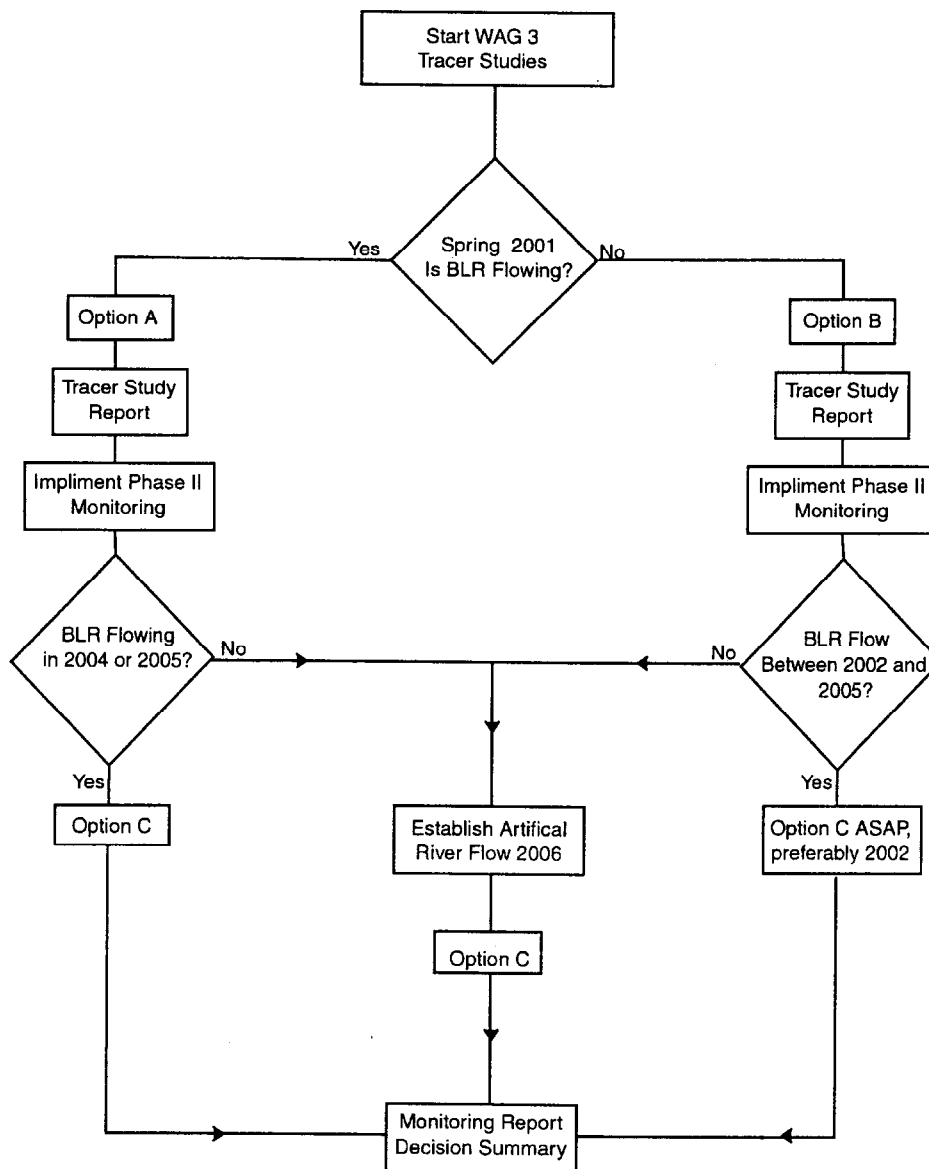


Figure 5-5. Logic Diagram /Flow Chart for Tracer Test Activities.

level measurements and sampling. Each Phase II well with sufficient water will also be equipped with a pressure transducer to measure water levels. The suction lysimeters and tensiometers will be installed in the primary perching zones. Lysimeter and tensiometer placement in the perched water zones will allow for continued contaminant sampling as the saturation level decreases as well as for the collection of moisture measurements.

The Phase II activities include the routine sampling and analysis for the OU 3-13, Group 4, Perched Water. Perched water wells will be sampled annually. Analytes include the COCs (tritium, technetium-99, iodine-129, strontium-90, plutonium isotopes (Pu-238, -239, -240, -241, and -242), uranium isotopes (U-234, -235, and -238), neptunium-237, americium-241, cesium-137 and mercury) along with TAL metals (calcium, magnesium, sodium, potassium, strontium, antimony, arsenic, beryllium, cadmium, chromium, lead, silver, thallium plus boron and strontium). Samples will be analyzed for anions (sulfate, chloride, bromide, fluoride, nitrate, nitrite and phosphate). Samples will be analyzed for hazardous substances (1,1,1-TCA, carbon tetrachloride, TCE, PCE, benzene, toluene, carbon disulfide, and pyridine), if detected in concentrations above applicable MCLs in the initial sampling. Samples will be analyzed for the COCs listed above annually during Phase II, and all other analytes listed above biannually (every 2nd year).

5.3.1 Drawings and Specifications

This section outlines the specifications for the information that will be collected to make a decision on the need to implement the BLR contingency. Drawings for the Phase II wells are provided (Figure 5-4, above), but they are subject to change, depending on Phase I findings.

5.3.1.1 Specifications. This subsection presents methods and materials that will be used in the successful completion of Phase II work. The deepest hole in each well set will be drilled first, with continuous core collection from ground surface to total depth. Coring operations will start with a PQ-size wire-line core barrel. As perched zones are encountered, they will be cased off and the core barrel size reduced accordingly to prevent contaminant movement to lower, possibly cleaner, perched zones, as the borehole is being advanced. Additional details on the drilling and sampling to be done during Phase II can be found in the FSP for OU 3-13, Group 4, Perched Water, Well Installation.

Phase II well details are provided in Table 5-3. Projected well depth, instrumentation and hole size are also shown.

Upon reaching the target depth, each borehole will be geophysically logged. At a minimum, logging will consist of video, caliper, natural gamma, deviation, gamma-gamma, neutron, density, and high-resolution gamma spectroscopy. All geophysical logs will be used for comparison of information and to assist in the determination of instrument placement. Down-hole logging will be performed by the INEEL field office of the USGS and BBWI personnel.

Upon completion of down-hole logging, the open boreholes will be equipped with instrumentation to provide for long-term monitoring of vadose zone moisture and the collection of pore water samples. Results of the well logging will be used to determine the exact placement of the instrumentation. It is anticipated that each borehole will be equipped with two tensiometers, two suction lysimeters, and a moisture sensor. In addition, one aquifer skimmer well will be installed as part of the well set. Tensiometers will be placed such that one is located below the interbed and one is at the top of the interbed. Suction lysimeters will be installed in a similar manner to the tensiometers. They will be placed such that the porous ceramic sample cup is located at approximately the top of the interbed. All upper and lower wells may also have piezometers (2-in. for upper, 4-in. for lower) installed if free water is encountered.

Table 5-3. Potential Phase II Well Installation Details.

Well Type	Projected Depth	Approximate Borehole Size	Proposed Instrumentation
Shallow Perched	120 to 140 ft bgs	6 to 12 in.	2 lysimeters 2 tensiometers 1 moisture sensors 2 in. piezometer
Deep Perched	380 to 400 ft bgs	6 to 12 in.	2 lysimeters 2 tensiometers 1 moisture sensors 4 in. piezometer
Aquifer Skimmer	450 to 475 ft bgs	10 to 12 in.	6 in. monitoring well- screened across water table

The aquifer wells will be constructed with minimum 6-in. 304 stainless steel 40-slot screen and Schedule 5 casing. A dedicated submersible pump with a stainless steel discharge line will be installed. After reaching the target depth and upon completion of geophysical logging (in the deep borehole), the screen and casing will be lowered into the open borehole. For aquifer wells, it is anticipated that 7.6 m (25 ft) of screen with a 1.5-m (5-ft) sump will be used. The screened interval will extend 1.5 m (5 ft) above the static water table. The bottom of the screen will extend across the first fractured interval. The exact screen length will be determined in the field. After placing the screen/casing assembly, the annular space around the screen will be filled with clean silica sand as a filter pack. Sand will extend to approximately five feet above the top of the screen. A 1.5-m (5-ft) granular bentonite plug will be placed on the filter pack and hydrated. After full hydration of the bentonite the remaining annulus will be filled with a non-shrink cement grout.

For perched zones where sufficient perched water is encountered, piezometers will be installed. The screen bottom will be placed as close as practical to the top of the interbed. A dedicated submersible pump may be installed, also with a stainless steel discharge line. Motor size of the submersible pump will be determined based on the depth to water.

Wells will be developed after completion; however, the criteria and method for development will be determined in the field based on the available water in each well. It is anticipated that some wells will have only a couple of inches of water, so that full well development cannot be performed. Details on well development can be found in Appendix B.

Existing perched zone wells will receive instrumentation consistent with their intended use. At a minimum, this will include pressure transducers in all existing perched wells that have water. Other equipment that may be installed includes dedicated pumps and tensiometers. Tensiometers may be installed by backfilling the screened interval with silica flour.

5.3.1.2 Proposed Well Locations. Figure 5-1 above shows the proposed locations for the Phase I wells. Locations for the Phase II wells are approximate and could change, depending on the Phase I findings.

5.3.1.3 Well Instrumentation Diagrams. Figure 5-2 shows the typical aquifer well installation. Figure 5-3b and Figure 5-3c show the typical perched zone instrument installation.